CRANE CERTIFICATION
TRAINING PACKAGE

for

PAVEMENTS AND CONSTRUCTION EQUIPMENT OPERATOR

(3E2X1)

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WHEEL-MOUNTED CRANE

USE CerTest # 8163 for general knowledge and # 8164 for hand signal examination.

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WHEEL-MOUNTED CRANE

TASK TRAINING GUIDE

STS Reference Number/Title:	• 19., CRANES • 20., RIGGING AND LIFTING	
Training References:	• AFOSH Standard 127-10, Civil Engineering • AFOSH Standard 91-46, Material Handling Equipment • TO 36-1-5, Rules on Safety • ANSI B30.5, Crawler, Locomotive, and Truck Cranes • FM 5-125, Rigging Techniques, Procedures, and Field Applications • NAVEDTRA 12535 Basic Equipment Operator (Navy) • OSHA Standard 29 CFR 1910.178 • OSHA Standard 29 CFR 1910.180 • OSHA Standard 29 CFR 1926.550 • 3E2X1 CDC, Pavements and Construction Equipment Operator	
Prerequisites:	• AF Form 171, Request for Driver's Training (Initial Training Only) • AF Form 2293, Government Vehicle Operator's Permit	
Equipment/Tools Required (quantity):	• 15-Ton wheel-mounted crane • 2-sheave hook block • ½ yard clamshell • Personnel work platform • Wire rope calipers • Open end wrenches (1/2 inch and ¾ inch) • Adjustable wrenches (10 inch and 15 inch) • Pliers, 10 inch slip joint • Pliers, needle point • Marling spike, 16 inch • Punch, 8 inch • Hammer, 2 lb. • Grease Gun • Clips, Crosby type, 9/16 inch • Wedge Socket • Shackles, ½, 5/8, ¾, and 1 inch • Sling 6x19x5/8x12′ IPS IWRC wire rope • Sling 6x19x5/8x16′ IPS IWRC wire rope • Sling, 4 leg with master link 6x19x5/8x 16′ IPS IWRC wire rope	1 1 1 1 1 1 1 1 1 1 1 1 2 ea. 1 4 ea. 2 ea. 2 ea. 1 ea.
Equipment/Tools Required (quantity):		

	• Sling, 4 leg with master link 6x19x3/4x16′ IPS IWRC wire rope 1 ea. • Sling 4″x16′x4-Ply nylon web 2 ea. • Rope, nylon, 1/2inch x 16 feet 2 ea. • AF Form 1806, Operator's Inspection Guide and Trouble Report • AF Form 810, Operator's Inspection Guide and Trouble Report • Manufacturer's Operating Manual • Required Safety Equipment • Personal Protective Equipment
Learning Objective:	• To certify heavy equipment operators in operating procedures of the wheel-mounted crane
Samples of Behavior:	• Understand general knowledge of the wheel-mounted crane • Understand crane safety • Understand rigging • Perform operator's inspection • Perform operator maintenance • Perform crane setup • Efficiently operate a wheel-mounted crane using attachments • Pass practical and CerTest # 8163 and # 8164
Notes:	
• Personnel are required to wear all personal protective equipment pertaining to each task (i.e. work gloves, hearing protection, and safety goggles)	
• Any safety violation is an automatic failure	

INTRODUCTION

Background: Only trained and authorized persons are permitted to operate a crane. Extensive and specific operation rules and instructions are detailed in AFOSH Standard 91-46, Chapter 8. When conducting training, these rules must be thoroughly explained to and learned by the trainee. A list of approved instructors must retained on file by the using activity and the vehicle operations section.

Certification: All certified crane operators must possess an AF Form 2293, US Air Force Motor Vehicle Operator Identification Card and an AF Form 483, Certificate of Competency. The only exception to this rule is that persons in training under the direct supervision of a qualified operator can also operate a crane. In order to be a certified crane operator, candidates must pass a written test containing the safety requirements contained in AFOSHSTD 91-46, Chapter 8 and TO 36C-1-5, 60 Rules of Safety. The candidate must also pass a practical operating examination to demonstrate task-qualification to operate the crane safely. Certification must be documented with the name of the operator, date of training or date of evaluation, and the name of the person(s) who conducted the training or evaluation. Certification is documented on AF Form 483, Certificate of Competency and the names forwarded to the vehicle operations officer.

All certified crane operators must be re-certified annually. To be re-certified, they must pass a medical examination, written safety test and practical operating examination.

Training Program Implementation: Training must consist of a combination of formal instruction (lecture, discussion, video, written material), practical training (demonstrations performed by the trainer and exercises performed by the trainee), and an evaluation of the trainee's performance in the workplace.

Recommended Training Time:

- Classroom (32 hrs)
- Practical applications (40 hrs)
- (CerTest) Examination (2 hr)
- Practical Examination (6 hrs)

Training Program Content: Along with passing a written exam, initial training, as a minimum, must include the following:

Crane related topics

- All operating instructions, warnings, and precautions for the type of crane the operator will be authorized to operate.

- Controls and instrumentation: location, what they do, and how they work.
- Engine or motor operation.
- Steering and maneuvering.
- Visibility (including restrictions due to loading).
- Attachment adaptation, operation, and use limitations.
- Load capacity.
- Vehicle stability.
- Vehicle inspection and maintenance.
- Refueling and/or charging and recharging of batteries.
- Operating limitations.
- Any other operating instructions, warnings, and precautions listed in the operator's manual for the type of crane the individual is being trained to operate.
- Fire extinguisher training, which will be accomplished annually after initial instruction. All material lifting equipment powered by internal combustion engines will be equipped with fire extinguishers as determined by the local fire chief.

Workplace related topics

- Crane safety.
- Interpreting load charts.
- Rigging and lifting.
- Operating in hazardous locations.
- Other unique or potentially hazardous environmental conditions that exist or may exist in the workplace.

Refresher Training: Refresher training, including an evaluation of the effectiveness of the training must be conducted to ensure the operator has the knowledge and skills needed to safely operate a crane. If an operator has previously received training on the above listed items, additional training in that topic is not required if the operator has been evaluated and found competent to operate the crane in a safe manner.

Refresher training is an annual requirement. All certified crane operators must be re-certified. The date of the previous training/evaluation controls the time frame for the next evaluation.

Recommended Training Time:

- Explain the principles of operation (30 min)
  Explain the importance of the crane to the mission and principles of operation.

- Explain and demonstrate use of AF Form 1806 and AF Form 1810 (30 min).
  Explain the difference between AF Form 1800, 1806, and 1810. Go over, in detail, the 1810.

- Perform preventive and operator maintenance (1 hrs).
  Using AF Form 1810 and manufacturer's operating manual, discuss the importance of maintenance and what to do with identified damage and safety discrepancies. Conduct hands-on training to include performing preventive and operator maintenance.

- Practice operation the crane under the supervision of a trainer (4 hrs).
  Demonstrate the operating capabilities from starting the engine to lifting a load to shutting down.

- Evaluation of operating capabilities (1 hr)
  Let trainee demonstrate their capability to operate a crane. All areas identified in the "initial training program content" must be addressed. Conduct training in an area that does not endanger the trainee or those within the immediate area.

- Pass CerTest test (1 hr)
  See Unit Education Training manager to complete CerTest # 8163 and # 8164

Feedback: Trainer should provide positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

WHEEL-MOUNTED CRANE

UNIT 1

GENERAL KNOWLEDGE

UNIT 1

GENERAL KNOWLEDGE

Cranes are classified as **weight-handling equipment** and are designed primarily to perform weightlifting and excavating operations under varied conditions. To make the most efficient use of a crane, you must know their capabilities and limitations.

Wheel-mounted cranes range in various sizes and have capacities from 5 to 35 tons or larger (fig. 1-1). The wheel-mounted cranes shown in figure 1-1 are hydraulically operated, four-wheel drive, four-wheel steer, pneumatic-tired, engine-powered diesel. The superstructure consists of a telescoping boom, single-acting hydraulic lift cylinders, a hydraulically operated hoist drum, and a hook block attachment.

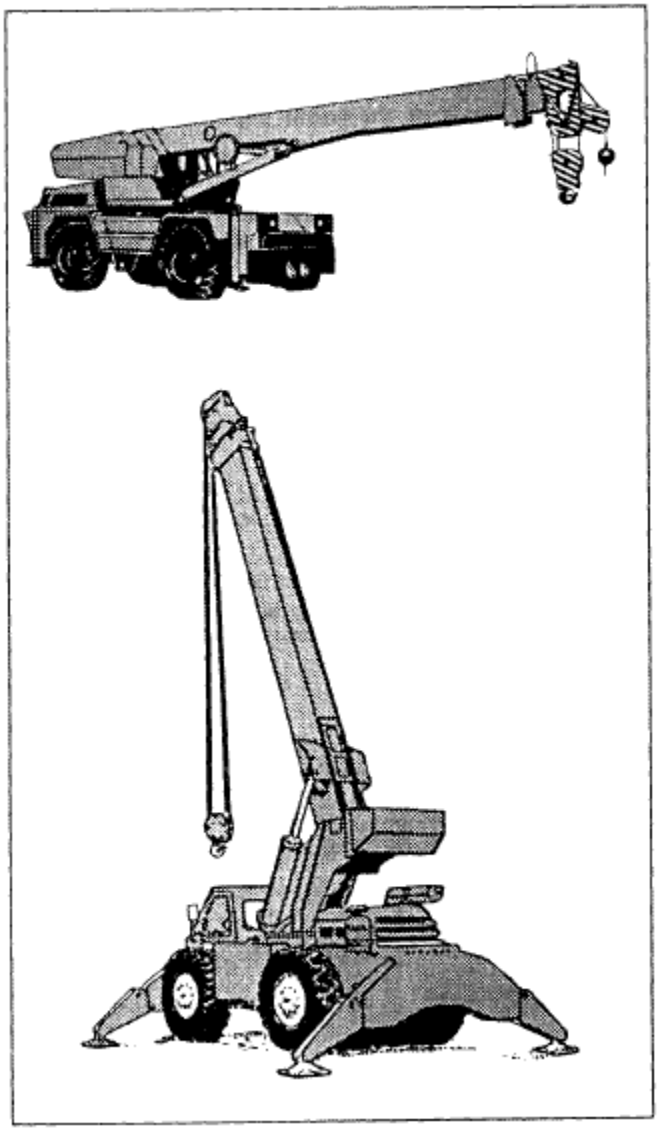


Figure 1-1. Wheel mounted cranes

The wheel-mounted crane has a ground bearing pressure of about 35 psi and can travel at speeds ranging from 2 to 30 mph. It can turn in a 30-foot radius with two-wheel steering and in a 17-foot radius with four-wheel steering and can travel up a firm, dry 40-percent grade.

The wheel-mounted crane is a mobile and flexible crane that can be driven on or off roads over rough terrain. It is best suited for lifts around shops or for supporting fabrication projects that call for many varied, mobile lifts within a small working area.

Depending on the make and model, most wheel-mounted cranes have a 360-degree work area. The quadrants of operation for wheel-mounted cranes are over each side, over the rear, and over the front (fig. 1-2). **Remember** that the capacity of the crane may change when rotating a load from one quadrant to another. This information is provided on the crane load chart.

Wheel-mounted cranes typically have telescopic booms and are commonly called hydraulic cranes. The booms are composed of a series of rectangular, trapezoidal, or other shape of symmetrically cross-sectional segments, fitting into each other. The largest segment, at the bottom of the boom, is called the **base section** or **boom butt.** The smallest section, at the top of the boom, is called the tip section or boom tip. In between there can be one or more sections called the **first, second, and so forth, sections.** With the boom fully retracted, the telescopic boom crane is highly maneuverable and easy to transport to job sites. Telescopic boom crane nomenclature is shown in figure 1-3.

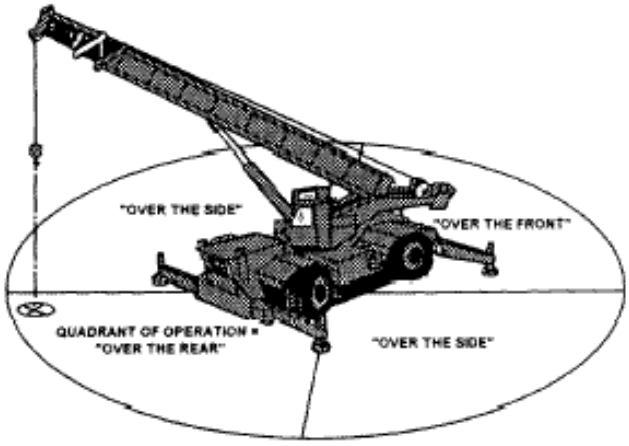


Figure 1-2. Wheel-mounted crane quadrants of operation

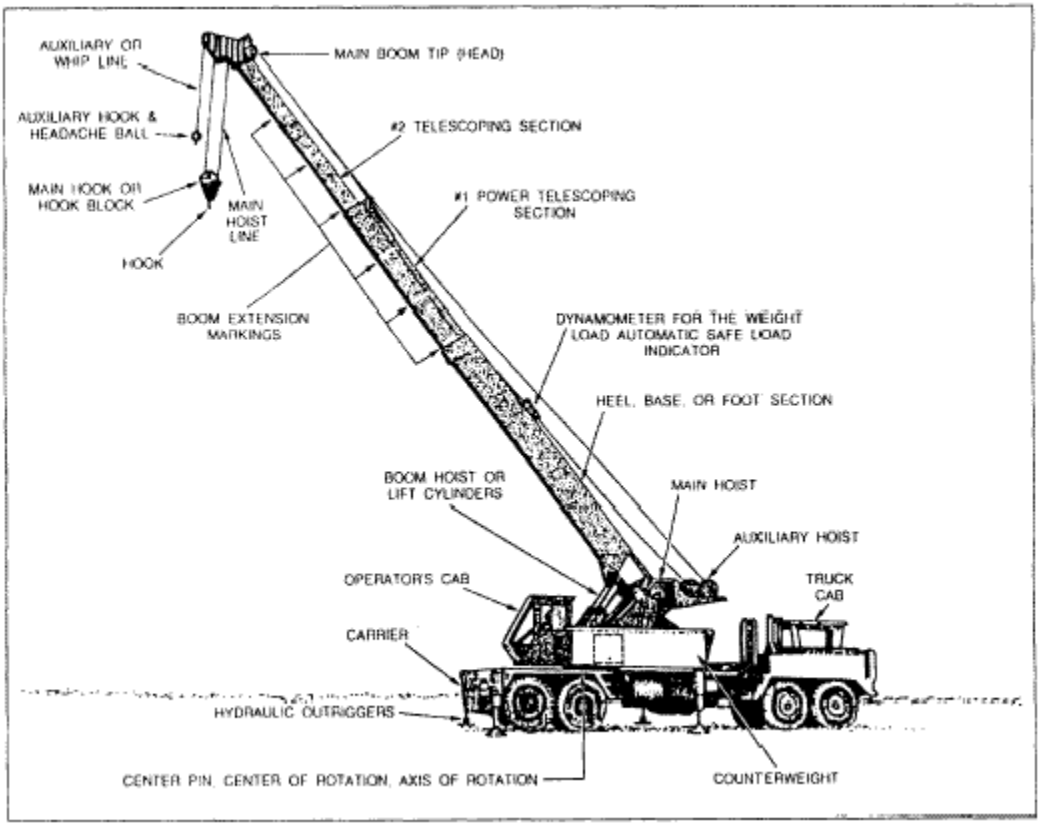


Figure 1-3. Telescopic boom nomenclature

Sections
Telescopic booms may be **a pinned boom, full-powered boom,** or a combination of both. A "pinned boom" means the sections are pinned in the extended or retracted position. A "full-powered boom" means the sections extend or retract hydraulically. Some models have a full-powered main boom with a pinned boom tip section. Read the operator's manual for the proper operation of the type of boom that is equipped on the crane you are assigned to operate.

On a full-powered boom, the sections are extended and retracted (except for the base section) by hydraulic cylinders, called extension cylinders. The cylinders are mounted parallel to the boom center line within each section. The boom extension cylinders on most telescopic booms have sequencing valves that allow the sections to extend (telescope) by equal amounts. These cranes usually have a single telescope control lever in the cab. However, on cranes not equipped with sequencing valves, the operator will have to extend each section equally. (The crane will have two or three boom telescope control levers in the cab, each controlling only a single boom section.). If the boom sections are extended unequally, the most fully extended section of boom could bend to uneven stresses. Additionally, the load chart will be invalidated for determining rated capacity of the crane. Boom sections that are marked off in equal increments, as shown on the boom in figure 1-3, make it easier for the operator or signalman to make sure each section is extended equally.

When a load is placed on a telescopic boom, the load weight on the boom causes the hydraulic rams within the boom to stiffen up and slightly curve. As the load is removed from the boom, the rams return straight. Because of this, do not extend the boom while it is under load. Read the operator's manual for boom extension information.

Hoisting Mechanism
The hoisting mechanism for a telescopic crane is a hydraulically powered hoist drum. The hoist drum is mounted behind the boom on the crane house or revolving turntable. Some hydraulic cranes are equipped with two hoist drums: one for the main hoist and the second for the auxiliary or whip line.

House Assembly
The house assembly is a revolving unit that supports the boom. Some small hydraulic cranes have the operator's cab and counterweight attached to the revolving unit.

Operator's Cab
The telescopic crane will have hoist, swing, and boom control levers similar to the cab of the lattice boom crane. Control lever(s) is/are also provided to extend and retract the boom. The hoist system does not require foot-controlled brakes. When the hoist control lever is returned to the neutral position, the hydraulic system holds the load in place.

Power Source
The power for a telescopic crane comes from hydraulic fluid. In most cases, the main carrier engine drives the hydraulic pump that supplies the hydraulic fluid to hydraulically controlled components. Power is diverted to hydraulic motors or cylinders by the valve

body at the operator's control station. The hydraulic power provides positive control of all crane functions.

Counterweight
The counterweight on a telescopic crane provides greater stability when lifting loads. When you are performing near-capacity lifts at high boom angles using a telescopic crane, about 60 percent of load weight is placed on the outriggers away from the load. When you are performing the same lift with a lattice boom crane, about 60 percent of the load is placed on outriggers close to the load.

CRANE ATTACHMENTS

The crane is a versatile piece of equipment that can be equipped with various attachments to perform a number of different operations. These attachments include a hook block, a clamshell, a dragline, and a working platform.

Hook Block
A crane that is rigged with a hook block is the primary unit for lifting an object or load, transferring it to a new place by swinging or traveling and then placing the load. Figure 1-4 shows an eight-part line rigged hook block.

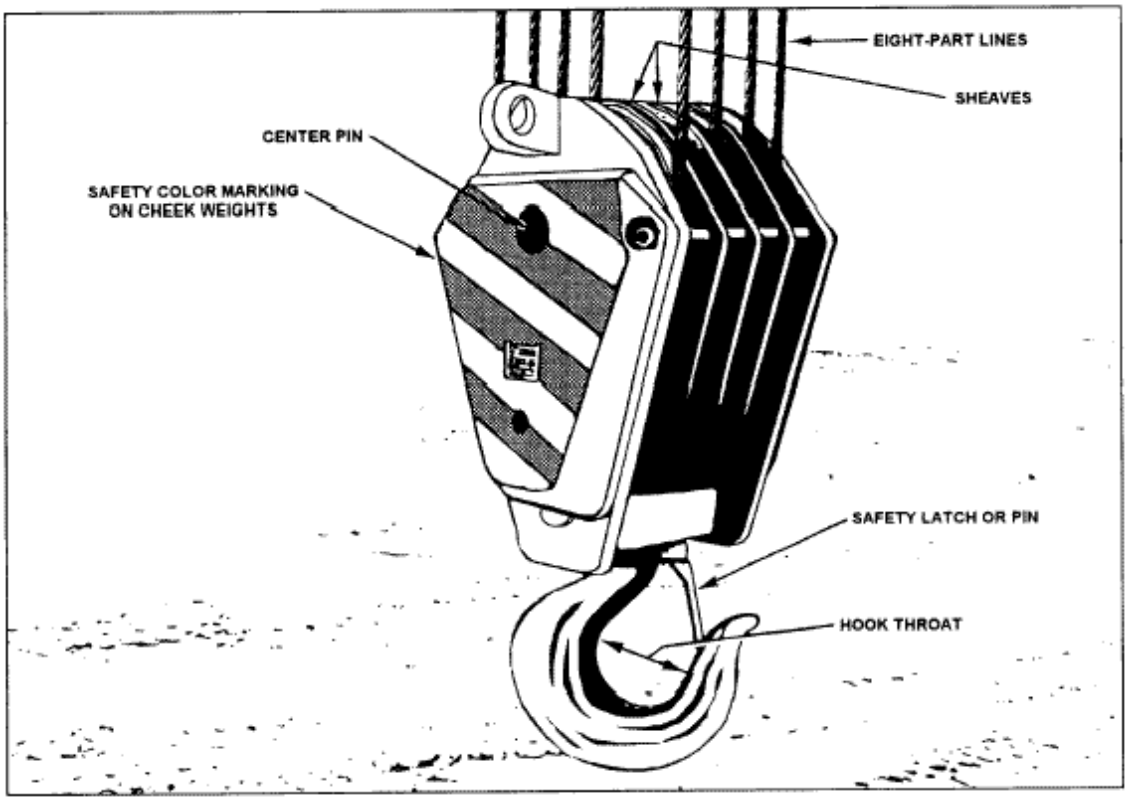


Figure 1-4. Hook block

The number of parts of a line rigged on the hook block is important for figuring the capacity of the crane. Most crane load charts show the rated capacity of the crane for different parts of the line; for example, a crane that is capable of being rigged with a eight-part line is rigged with a six-part line. The eight-part line gives the crane a greater lifting capacity; therefore, you must check the load chart for the six-part line capacity to avoid overloading the crane.

Clamshell

A clamshell consists of hoist drum lagging, clamshell bucket, tag line, and wire ropes to operate holding and closing lines. On some crane models, the hoist drum lagging (hoist drum diameter) can be changed to meet the speed or pull requirements for clamshell operations. Once a crane is rigged with a clamshell, the crane is referred to by the name of the attachment.

When changing attachments from a hook block to a clamshell, check the operator's manual for the correct length of wire rope reeving. For example, some crane models require 300 to 400 feet of wire rope for hook block operations and only 100 to 200 feet of wire rope for clamshell operations. Too much wire rope on the hoist drum during clamshell operations will cause the wraps of wire rope to loosen on the hoist drum and cross wind, resulting in crushed wires and kink spots in the wire rope. This is very expensive, because the wire rope is usually no longer useful for hook block operations.

Changing the length of rope requires unreeving the hook block wire rope and reeving the correct length of wire rope for the clamshell. This may be a time-consuming effort, but saves you from having to replace 300 to 400 feet of wire rope when the crane is rigged for hook block operations.

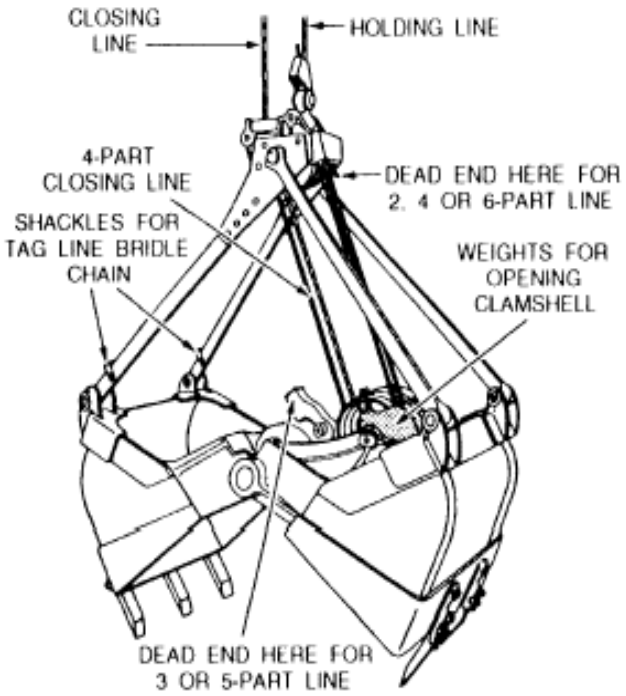


Figure 1-5. Clamshell bucket

The clamshell bucket (fig. 1-5) is two scoops hinged together in the center with counterweights bolted around the hinge. The two hoist drum wire ropes on the crane are rigged as the holding and closing lines for controlling of the bucket. An example of a clamshell rigging configuration is shown in figure 1-5.

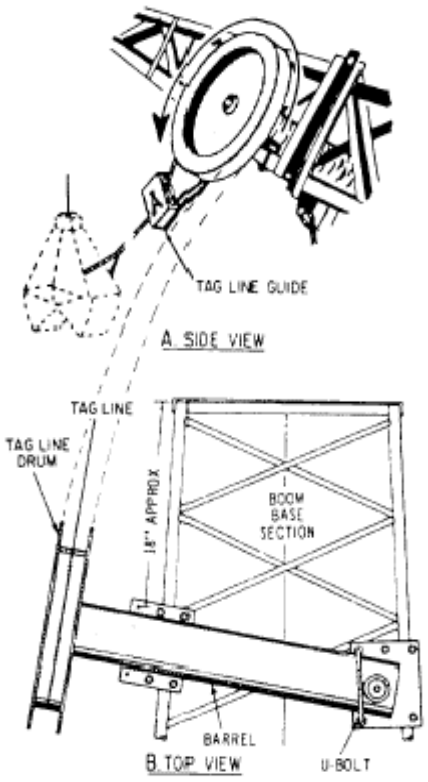


Figure 1-6. Tag line winder

The tag line winder (fig. 1-6) controls the tension on the tag line that helps prevent the clamshell from twisting during operations. Like the clamshell bucket, the tag line winder will exchange with most makes or models of cranes in the same-size range.

Working Platform

The working platform is a two-man, self-leveling, rectangular platform mounted to the nose or tip of the boom. It can be quickly mounted to convert the crane from a lifting operation to an aerial platform workstation. Automatic leveling is accomplished through a cylinder on the platform. This cylinder is connected to a master leveling cylinder on the crane boom. If needed, you can adjust the leveling from a switch on the control panel located inside the platform. There's also an additional leveling switch located inside the operator's cab for safety purposes.

WHEEL-MOUNTED CRANE

UNIT 2

OPERATOR QUALIFICATIONS

UNIT 2

OPERATOR QUALIFICATIONS

Background: Not every equipment operator is qualified to climb into the seat of a crane and operate it. Because of the potential for catastrophic damage to equipment and potential harm to people, it is very important that only trained and skilled operators run this vital piece of construction equipment. It is important that supervisors select individuals who are physically and mentally fit to operate cranes. The individual selected for crane operator training needs to meet certain qualifications. Air Force Occupational Safety and Health Standard (AFOSHSTD) 91-46 provides guidance concerning operator qualifications.

Crane operators must meet the following minimum physical qualifications:

- **Eyesight:** Must have minimum vision of 20/30 Snellen in one eye and 20/50 Snellen in the other eye, with or without glasses/contact lenses

- **Color Perception:** Must be able to distinguish red, green and yellow colors regardless of position of colors.

- **Hearing:** Must test 15/20 for ordinary conversation in one ear, with or without a hearing aid, to ensure there is adequate hearing for a specific operation.

- **Physical Fitness:** Must have sufficient strength, endurance, agility and speed of muscular reaction to meet the demands of equipment operations.

- **Physical defects or emotional instability:** Not withstanding the required physical examination, evidence of physical defects or emotional instability which could render the operator a hazard to himself or others, or which in the opinion of the examiner would interfere with the operator's safe or efficient performance of duties, may be sufficient cause for disqualification. In such case specialized clinical or medical judgements and tests may be required.

NOTE: A history of epilepsy or a disabling heart condition may be sufficient reason for disqualification.

Crane operators also have to have good depth perception, field of vision, reaction time, manual dexterity or coordination, and no tendencies to dizziness or similar undesirable characteristics.

Certification: Operating a crane is an inherently dangerous task. Therefore the only persons who are authorized to operate cranes are qualified operators possessing an AF Form 2293, US Air Force Motor Vehicle Operator Identification Card and an AF Form

483, Certificate of Competency. The only exception to this rule is that persons in training under the direct supervision of a qualified operator can also operate a crane.

In order to be a certified crane operator, candidates must pass a written test containing the safety requirements contained in this certification package. The candidate must also pass a practical operating examination to demonstrate task-qualification to operate the crane safely.

- All certified crane operators will be re-certified annually. They must pass a medical examination, written safety test and practical operating examination.

NOTE: Only authorized and qualified operators who possess a valid AF Form 483 will operate mobile cranes. A list of qualified crane operators will be kept by the using organization and appropriate entries will be made in the individual's training records.

WHEEL-MOUNTED CRANE

UNIT 3

CRANE SAFETY

UNIT 3

CRANE SAFETY

Background: Cranes and attachments are essential to the support of Civil Engineer (CE) operations. Lifting heavy objects, loading and unloading construction materials, and excavating earthwork materials are typical tasks accomplished by the use of cranes and attachments. Cranes and attachment procedures are a complex set of characteristics. Proper and efficient operation of cranes and their attachments requires more knowledge and skill than for any other piece of construction equipment you will operate.

NOTE: You must always be exceptionally safety conscious when working on or around crane operations of any type.

Safety is paramount in all crane operations. The equipment itself must be safe. It should incorporate safety in its design to reduce hazards. The crane should also be inspected properly and at regular intervals. Finally, required maintenance and testing needs to be performed on the crane in order to keep it within safety guidelines.

General Requirements. The following is a list of general design requirements that all cranes used by the Air Force must incorporate to reduce possible safety concerns.

Load Ratings and Charts. A rating chart with clearly legible letters and figures must be securely fixed to the crane cab in a location easily visible to the operator while seated at the control station. A duplicate load rating chart (legible from the ground) should also be provided on the outside of the crane.

Two-Blocking Prevention. On telescoping boom cranes, a two-blocking damage preventive feature must be provided. It should be capable of preventing damage to the hoist rope or other machine components when hoisting the load, extending the boom, or lowering the boom on a machine having a stationary hoist mounted to the rear of the boom hinge.

Boom Angle Indicator. A boom angle indicator must be on all cranes.

Overload Protection. Devices such as "Load Moment Indicators" are commercially available and are designed to alarm the operator and (or) de-energize the crane when attempting to lift a load that is beyond the capabilities of the crane. Although these devices would be of minimal value in routine base-level Air Force operations, they may be of some value in operations involving construction where load may not be defined or identified or when a load has not been properly released from its transporter. The user must evaluate the current and anticipated use of the crane to determine the need for such a device.

Color Coding for Strike Hazard. Those portions of crane cabs that extend beyond the main chassis when rotated must be color-coded yellow and black on the lower areas to denote a strike hazard to personnel on the ground. Colors must be reflective for night operations.

Guarding of Machinery. Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating parts (which might constitute a hazard to operating personnel under normal operating conditions) must be guarded.

Unguarded Machinery Conditions. Crane operations have inherent hazards, such as rotating equipment and (or) holes, etc., that cannot be mechanically safeguarded against. To prevent severe injury to personnel, they will exercise extreme care when they are exposed to unguarded and (or) rotating equipment and (or) holes. Such conditions must be clearly marked with appropriate warning decals.

Main Switch. If the mobile crane is electrically powered separately and incorporates a main or master switch, the switch will be designed so it can be locked in the open or "OFF" position. If there is a warning tag on the main switch do not operate the crane. Only the crane operator is authorized to remove warning tags.

Operator Protection. Cranes must be fitted with adequate equipment to protect operators from falling objects, swinging loads, and cable failures. Where cranes are operated in inclement weather, protection from the weather must also be provided.

Warning. An efficient audible warning device must be provided when hoisting operations or moving equipment might endanger personnel working in the area. The control of the device must be within easy reach of the operator.

Warning Sign. A permanent sign must be posted in the cab of the equipment in full view of the operator. This sign will read: **"DANGER HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines."** If equipment will be operated in the vicinity of power lines, the installation of a proximity device such as a di-electric boom tip device should be considered. If the boom does contact an electric line, the operator MUST stay inside the cab of the crane until the electric line is de-energized.

Night Operations. Cranes operated during darkness must have clearance lights installed. The working areas must be illuminated so the designated signal person, loads, rigging, and any obstructions are readily visible.

Inspections. Inspections are important for safe operation of any equipment. Cranes require daily, monthly, and annual inspections to ensure they are mechanically sound and in proper operating condition.

Daily Inspections. Crane operators are required to perform pre-operational inspections on the crane daily. The following items must be inspected:

Hydraulic hose, fittings, and tubing. All hydraulic hoses, particularly those which flex in normal operation of crane functions, must be visually inspected. Any deterioration should be examined and determination made whether further use of the component would constitute a safety hazard. Operators must inspect for any evidence of hydraulic oil leakage at the surface of the flexible hose or any excessive leakage at its junction with the metal end couplings. Also inspect for any blistering or abnormal deformation to the outer

covering of the hydraulic hose and hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening. Finally, inspect for evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting. If any of these are visible, action must be taken immediately to eliminate or correct the causes or otherwise protect the components from additional damage.

Pumps and Motors. The following may be reason for replacement or repair: loose bolts or fasteners, leaks at joints between sections, shaft seal leaks, unusual noises or vibration, loss of operating speed, suspected overheating of the hydraulic oil, and inability to hold proper pressure.

Valves. The following may be reason for replacement or repair: cracks in valve housing, improper return of spool to neutral position, leaks at spools or joints, and failure of relief valves to attain correct pressure setting as specified by the manufacturer.

Cylinders. The following may be reasons for replacement or repair: drifting caused by oil leaking across the piston, rod seals leaking, leaks at welded joints, scored, nicked, or dented cylinder rods, dented case (barrel), and loose or deformed rod eyes or connecting joints.

Filters. Evidence of rubber particles on the filter element may indicate hose, "O" ring, or other rubber component deterioration. Metal chips or pieces on the filter may denote failure in pumps, motors, or cylinders. Further checking is necessary to determine origin of the problem before corrective action can be taken.

Control Mechanisms. These mechanisms must be checked for maladjustment.

Monthly Inspections. The following items must be inspected by the operator or designated person for defects at intervals (at least monthly) specified by the Vehicle Maintenance Officer. The inspection will include observation during the crane's operation.

Check vehicle control mechanisms for excessive wear of components and contamination by lubricants or other foreign matter.

Check installed safety devices for proper operation.

Check crane hooks for deformations or cracks; or having more than 15 percent in excess of normal throat opening or more than 10 degrees twist from the plane of the unbent hook. If the crane hook exceeds the 15 percent deformation or 10 degrees twist, they are no longer serviceable.

Warning

Crane hooks showing any defects must be discarded. Field repairs by welding or reshaping will not be permitted. **EXCEPTION:** See ANSI B30.10.

Check rope reeving for compliance with crane manufacturer's recommendation.

Check electrical apparatus for malfunctions, signs of excessive deterioration, or dirt and moisture accumulation.

Check hydraulic hoses, fittings, and tubing for deterioration.

Annual Inspections. The Vehicle Maintenance Officer is responsible for ensuring complete inspections of the crane are performed at intervals (**at least annually**) or as directed or recommended by the manufacturer. These inspections must be performed by a qualified person and must include all items identified as daily inspection requirements, monthly inspection requirements, and the following items:

Check deformed, cracked, or corroded members in the crane structure and boom.

Check loose bolts or rivets.

Check cracked or worn sheaves and drums.

Check worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers, and locking devices.

Check excessive wear on brake and clutch system parts, linings, pawls, and ratchets.

Check any inaccuracies of load and check boom angle indicators and other indicators over their full range.

Check proper performance of gasoline, diesel, electric, or other power plants.

Check excessive wear of chain-drive sprockets and excessive chain stretch.

Check cracks in crane hooks by magnetic particle or other suitable crack detecting inspection.

Check proper operation of travel steering, braking, and locking devices.

Check worn or damaged tires.

Check rust on hydraulic rods and control valves.

Check cleanliness of oil filters and oil strainers.

NOTE: For nuclear certified mobile hydraulic cranes, perform an annual load test of 100 percent of the rated capacity. Upon completion of the load test, the weight load test date must be stenciled on the lower boom assembly.

Cranes that are not in regular use also require mandatory inspections. A crane which has been idle for a period of 1 month or more, but less than 6 months must be given an inspection conforming with the requirements of a daily inspection. Also the wire rope must be given an inspection conforming to requirements in Chapter 9 of AFOSHSTD 91-46. A crane which has been idle for a period of over 6 months must be given a complete inspection conforming with all requirements of the daily, monthly, and wire rope inspections before being placed before being placed in service.

Standby cranes will be inspected at least semiannually according to the requirements of the daily, monthly, and wire rope inspections. Inspections may need to be more frequent if cranes are exposed to adverse environments.

Inspection Records. Inspection records will be maintained according to AFI 24-302 (formerly designated AFM 77-310, Volume 2), Vehicle Maintenance Management, or other appropriate directives. The user will determine the location of inspection records.

Maintenance and Testing. Proper maintenance and testing of cranes is crucial to the safety of crane operations.

Maintenance. A preventive maintenance program must be established to ensure the crane stays in good mechanical shape. Any unsafe conditions, disclosed by the inspection requirements, must be corrected before the crane is operated again. Only designated personnel may make adjustments and repairs. Records of maintenance on the crane will be maintained according to AFI 24-302 or other appropriate directives.

Load Testing. Prior to initial use, extensively repaired or modified cranes will be load tested to 110 percent of rated capacity by the owning activity. Upon completion of the test, the weight load test date will be stenciled on the lower boom assembly as per TO 00-20B-5, USAF Motor Vehicle and Vehicle Equipment Inspection. A new crane will have the manufacturer's certification that all load testing has been accomplished.

NOTE: For nuclear certified mobile hydraulic cranes, perform an annual load test of 100 percent of the rated capacity. Upon completion of the load test, the weight load test date must be stenciled on the lower boom assembly.

Test loads will not exceed 110 percent of the rated load at any selected working radius. If it is determined that re-rating is necessary, crawler, truck and wheel-mounted mobile cranes will be tested according to Society of Automotive Engineers, Inc. (SAE) Recommended Practices, Crane Load Stability Test Code J765. A copy of the re-rating

test report will be provided to Vehicle Maintenance Control and a copy posted in the cab of the crane.

NOTE: Cranes will not be re-rated in excess of the original load ratings unless the crane manufacturer approves the rating change.

A record of all tests will be maintained by the owning and (or) using agency. Also test weights utilized for load testing shall be tagged or adequately marked indicating total weight in pounds and owner and (or) agency identification number. Rebar steel shall not be used for test weight lift points.

Additional Safety Requirements:
AFOSHSTD 91-46 contains strict safety guidelines that must be adhered to by all crane operators. They are:

(a) The operator will not divert his or her attention elsewhere while operating the crane. He or she will first stop the crane, and then proceed with the new task.

(b) The operator will respond to signals only from the appointed signal person. A stop signal will be obeyed at any time, no matter who gives it.

(c) The operator will be responsible for those operations under his or her direct control. Whenever there is any doubt as to safety, the operator shall have the authority and responsibility to stop and refuse to handle loads until safety has been ensured.

(d) If an audible warning signal is furnished, the operator will sound it each time before traveling and when approaching workers or other congested areas.

(e) Before leaving the crane unattended, the operator will:

1. Land (set down) any suspended load, bucket, lifting magnet, or other device.
2. Disengage clutch.
3. Set travel, swing, boom brakes, and other locking devices.
4. Put controls in the “OFF” or neutral position.
5. Stop the engine.
6. Secure crane against accidental travel.

(f) During period of non-use or weather alerts, the operator will lower the boom to ground level, to a resting platform, or otherwise ensure the boom is secure against displacement from wind loads or other outside forces.

(g) If there is a warning tag on the switch or engine starting controls, the operator will not close the switch or start the engine until an authorized person has removed the warning tag.

(h) Before closing the switch or starting the engine, the operator will ensure that all controls are in the OFF position and all personnel are in the clear control position.

(i) If power fails during operation, the operator will:

1. If practical, land the suspended load under brake

2. Set all brakes and locking devices.

3. Move all clutch or other power controls to the "OFF"

(j) The operator will familiarize him or herself with the equipment and its proper care. The operator will conduct a pre-operational inspection before using the crane. If adjustments or repairs are necessary or any damage is known, he or she will report them promptly to the supervisor and will record them on Air Force Technical Order (AFTO) Form 89, "Daily Inspection Worksheet for Locomotive Cranes Other Than Steam," or other appropriate inspection and maintenance forms.

(k) The operator at the start of a new shift will test all controls. If any controls do not operate properly, they will be adjusted or repaired before the operation is continued.

(l) When rotating the crane, sudden starts and stops will be avoided. Rotational speed will be such that the load can be controlled. A tag or restraint line will be used when rotation of the load is hazardous.

(m) When a crane is to be operated at a fixed radius, the boom hoist pawl or other positive locking device will be engaged on rope supported booms.

(n) Ropes will not be handled on a winch head without the knowledge of the operator. While a winch head is being used, the operator will be within convenient reach of the power unit control level.

(o) On cranes having a powered telescoping boom, the hook is drawn closer to the boom head when hoisting, extending the boom, or lowering a boom on machines where the winch is mounted stationary to the rear of the boom hinge. If the machine is not equipped with a "two-blocking damage preventive feature," the rope must be "let-out" from the load hoist mechanism so the hook will not be jammed (two-blocked) against the boom head. The jammed condition may cause overload and result in rope and/or other component failure.

(p) Telescoping boom sections will be telescoped in the manner and sequence specified by the manufacturer.

Handling the Load:

(a) No crane will be loaded beyond its rated load. The weight of all loads will be determined before lifting. Outriggers will be set before lifting, telescoping the boom, or turning a load within the ratings.

(b) A load will not be transported on a crane unless the crane is designed for that purpose. Normally, the load will be placed on a vehicle designed and rated to handle the particular load and transported to the new location, where it can be off-loaded and placed by the crane without movement of the vehicles.

(c) When attaching the load, the hoist rope will not be wrapped around the load. The load will be attached to the hook by means of slings or other approved devices of proper capacity.

(d) When moving the load, the supervisor directing the lift will ensure that:

1. The crane is level and, where necessary, blocked properly.

2. The load is well secured and properly balanced in the sling or lifting device before it is hoisted more than a few inches.

(e) Before starting to hoist, the operator wall ensure that:

1. The hoist rope is not kinked.

2. Multiple part lines are not twisted around each other .

3. The hook is brought over the load in a way that prevents swinging.

4. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves.

(f) During hoisting the operator will take care that:

1. There is no sudden acceleration or deceleration of the moving load.

2. Load and boom do not contact any obstructions.

(g) Side loading of booms will be limited to freely suspended loads. Cranes will not be used for dragging loads sideways.

(h) The crane will not be operated while anyone is on the load or hook.

Warning: Riding on the hook or load is ABSOLUTELY forbidden.

(i) The operator will not carry loads over personnel.

(j) On truck-mounted cranes, loads will not be lifted over the front area unless specifically allowed in the manufacturer's operating instructions.

(k) The operator will test the brakes each time a load is handled by raising it a few inches and applying the brakes.

(l) Outriggers will be used when the load to be handled at that particular radius exceeds the rated load without outriggers, as given by the manufacturer for that crane or if the ground where the lift is to be made is soft or otherwise unstable. Where floats are used they will be securely attached to the outriggers. Blocking used to support outriggers will be strong enough to prevent crushing, be free from defects, and be of sufficient width and length to prevent shifting or toppling of the crane under load.

(m) Neither the load nor the boom will be lowered beyond the point where less than two full wraps of rope remain on their respective drums.

(n) When two or more cranes are used to lift one load, one designated person will be responsible for the operation. He or she will analyze the operation and instruct all personnel involved about proper positioning, rigging of the load, and the movements to be made.

(o) While holding the load:

1. The operator will not leave his or her position at the controls when the load is suspended.

2. No person will be permitted to stand or pass under a load on the hook.

3. If the load hoist mechanism is not equipped with an automatic brake and the load must remain suspended for a considerable length of time, the operator will hold the drum from rotating in the lowering direction.

SAFETY REVIEW

The following factors are basic guidelines to perform safe daily crane operations:

Determine the weight to be lifted and the crane required to make the lift safely.

Travel the proposed route the crane will follow to and from the project site, and complete the Crane Lift Checklist.

Obtain the travel permits if required.

Brief operators and riggers on the specifics of the lift and travel conditions.

Inspect the crane area setup for stability and safe operating area.

Fully extend the outriggers and use them according to the manufacturer's instruction.

Check the crane for levelness.

Inspect all rigging hardware.

Select the proper sling with sufficient capacity rating.

Center the sling in the base (bowl) of the hook to avoid hook point loading, and ensure the hook block is always placed over the center of the load to eliminate shock loading of the slings or cranes, resulting from load shifts when a lift is made.

Make ample safety allowances for unknown factors.

Stand clear of and do not walk under suspended loads.

Boom deflection. All crane booms have deflection. When the load is lifted off the ground, the boom will deflect, causing the radius to increase. Increased radius may cause overloading of the crane.

An uncontrolled swinging load can cause the radius to increase.

Clean operating area. Water coolers, excess tools, grease, soda cans, and other unnecessary items should be kept outside of the operating area of the crane. Water coolers must be kept off the crane to prevent people from congregating around the crane when in operation.

NOTE: Safe lifting is PARAMOUNT! Project completion must not interfere with safe crane operations.

WHEEL-MOUNTED CRANE

UNIT 4

RIGGING

UNIT 4

RIGGING

Rigging is a technique of handling materials using wire rope, fiber rope, chains, slings, spreader bars, and so forth. Rigging is a vital link in the weight-handling process. In Civil Engineering (CE), an in-depth management program for maintenance and use of all rigging gear is essential to ensure entire weight-handling operations are performed safely and professionally. This unit covers the characteristics, maintenance, usage, and storage of rigging gear used in weight-handling operations.

WIRE ROPE

Many of the movable components on cranes and attachments are moved by wire rope. Wire rope is a complex machine, composed of a number of precise, moving parts. The moving parts of wire rope are designed and manufactured to bear a definite relationship to one another to have the necessary flexibility during operation. Wire rope may be manufactured by either of two methods. If the strands, or wires, are shaped to conform to the curvature of the finished rope before laying up, the rope is termed **preformed wire rope.** If they are not shaped before fabrication, the wire rope is termed **non-preformed wire rope.**

The most common type of manufactured wire rope is preformed. When cut, the wire rope tends not to unlay and is more flexible than non-preformed wire rope. With non-preformed wire rope, twisting produces a stress in the wires; therefore, when it is cut or broken, the stress causes the strands to unlay.

NOTE: When the wire is cut or broken, the almost instantaneous unlaying of the wires and strands of non-preformed wire rope can cause serious injury to someone that is careless or not familiar with this characteristic of the rope.

PARTS OF WIRE ROPE

Wire rope is composed of three parts: **wires, strands,** and **core** (fig. 4- 1). A predetermined number of wires of the same or different size are fabricated in a uniform arrangement of definite lay to form a strand. The required number of strands are then laid together symmetrically around the core to form the wire rope.

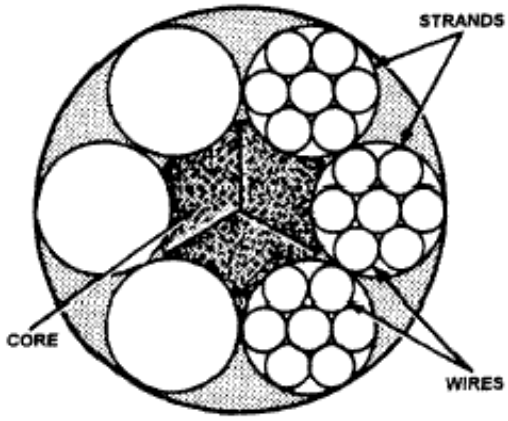
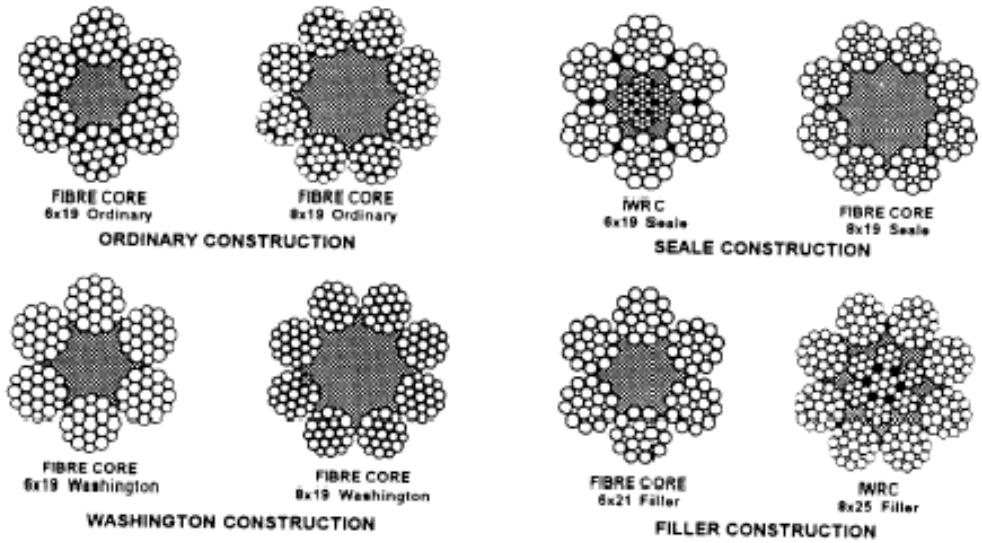


Figure 4-1. Parts of the wire rope.

Wire
The basic component of the wire rope is the wire.

The wire may be made of steel, iron, or other metal in various sizes. The number of wires to a strand varies, depending on the purpose for which the wire rope is intended. Wire rope is designated by the number of strands per rope and the number of wires per strand. Thus an 1/2-inch 6 x 19 rope has six strands with 19 wires per strand. It has the same outside diameter as a 1/2-inch 6 x 37 rope that has six strands with 37 wires (of smaller size) per strand.

Strand
The design arrangement of a strand is called the construction. The wires in the strand may be all the same size or a mixture of sizes. The most common strand constructions are Ordinary, Seale, Warrington, and Filler (fig. 4-2).



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Ordinary construction wires are all the same size.

Seale is where larger diameter wires are used on the outside of the strand to resist abrasion and smaller wires are inside to provide flexibility.

Warrington is where alternate wires are large and small to combine great flexibility with resistance to abrasion.

Filler is where very small wires fill in the valleys between the outer and inner rows of wires to provide good abrasion and fatigue resistance.

Core
The wire rope core supports the strands laid around it. The three types of wire rope cores are fiber, wire strand, and independent wire rope (fig. 4-3).

Figure 4-2. Common strand construction

A **fiber core** may be a hard fiber, such as manila, hemp, plastic, paper, or sisal. The fiber core offers the advantage of increased flexibility. It also serves as a cushion to reduce the effects of sudden strain and acts as an oil reservoir to lubricate the wire and strands (to reduce friction). Wire rope with a fiber core is used when flexibility of the rope is important.

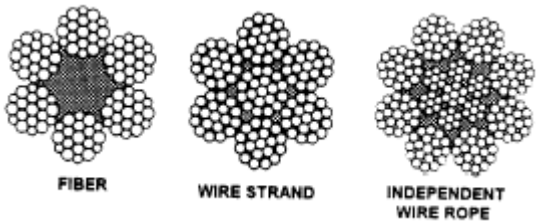


Figure 4-3. Core construction

A **wire strand core** resists more heat than a fiber core and also adds about 15 percent to the strength of the rope; however, the wire strand core makes the wire rope less flexible than a fiber core.

An **independent wire rope core** is a separate wire rope over which the main strands of the rope are laid. This core strengthens the rope, provides support against crushing, and supplies maximum resistance to heat.

GRADES OF WIRE ROPE

The three primary grades of wire rope are mild plow steel, plow steel, and improved plow steel.

Mild Plow Steel Wire Rope

Mild plow steel wire rope is tough and pliable. It can stand repeated strain and stress and has a tensile strength (resistance to lengthwise stress) of from 200,000 to 220,000 pounds per square inch (psi). These characteristics make it desirable for cable tool drilling and other purposes where abrasion is encountered.

Plow Steel Wire Rope

Plow steel wire rope is unusually tough and strong. This steel has a tensile strength of 220,000 to 240,000 psi. Plow steel wire rope is suitable for hauling, hoisting, and logging.

Improved Plow Steel Wire Rope

Improved plow steel wire rope is one of the best grades of rope available and is the most common rope used. This type of rope is stronger, tougher, and more resistant to wear than either mild plow steel or plow steel. Each square inch of improved plow steel can stand a strain of 240,000 to 260,000 pounds. This makes it especially useful for heavy-duty service, such as on cranes with excavating and weight-handling attachments.

LAYS OF WIRE ROPE

The term **lay** refers to the direction of the twist of the wires in a strand and to the direction that the strands are laid in the rope. In some instances, both the wires in the strand and the strands in the rope are laid in the same direction; and in other instances, the wires are laid in one direction and the strands are laid in the opposite direction, depending on the intended use of the rope. Most manufacturers specify the types and lays of wire rope to be used on their piece of equipment. Be sure and consult the operator's manual for proper application.

Five different lays of wire rope are shown in figure 4-4.

The five types of lays used in wire rope are as follows:

Right Regular Lay: In right regular lay rope, the wires in the strands are laid to the left, while the strands are laid to the right to form the wire rope.

Left Regular Lay: In left regular lay rope, the wires in the strands are laid to the right, while the strands are laid to the left to form the wire rope. In this lay, each step of fabrication is exactly opposite from the right regular lay.

Right Lang Lay: In right lang lay rope, the wires in the strands and the strands in the rope are laid in the same direction; in this instance, the lay is to the right.

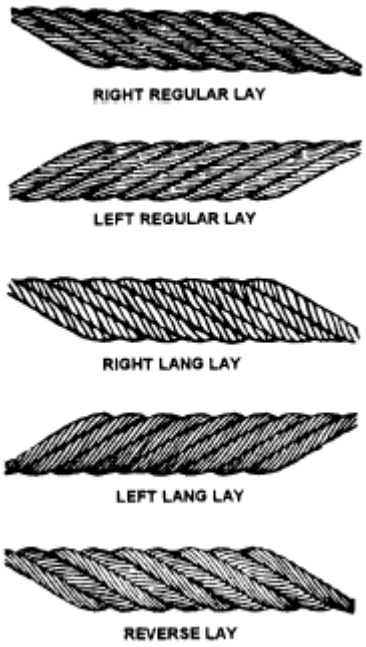


Figure 4-4. Lays of wire rope

Left Lang Lay: In left lang lay rope, the wires in the strands and the strands in the rope are also laid in the same direction; in this instance, the lay is to the left (rather than to the right as in the right lang lay).

Reverse Lay: In reverse lay rope, the wires in one strand are laid to the right, the wires in the nearby strand are laid to the left, the wires in the next strand are to the right, and so forth, with alternate directions from one strand to the other. Then all strands are laid to the right.

LAY LENGTH OF WIRE ROPE

The length of a rope lay is the distance measured parallel to the center line of a wire rope in which a strand makes one complete spiral or turn around the rope. The length of a strand lay is the distance measured parallel to the center line of the strand in which one wire makes one complete spiral or turnaround the strand. Lay length measurement is shown in figure 4-5.

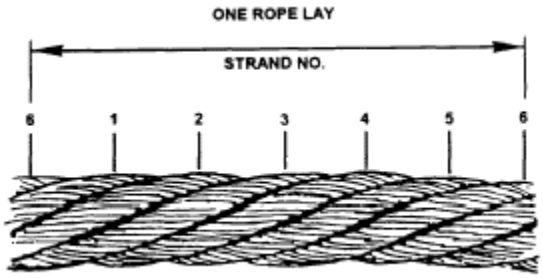


Figure 4-5. Lay length of wire rope

CHARACTERISTICS OF WIRE ROPE

The main types of wire rope used consist of 6, 7, 12, 19, 24, or 37 wires in each strand. Usually, the wire rope has six strands laid around the core.

The two most common types of wire rope, 6 x 19 and 6 x 37, are shown in figure 4-6. The 6 x 19 type (having six strands with 19 wires in each strand) is the stiffest and strongest construction of the types of wire rope suitable for general hoisting operations. The 6 x 37 wire rope (six strands with 37 wires in each strand) is very flexible, making it suitable for cranes and similar equipment where sheaves are smaller than usual. The wires in the 6 x 37 are smaller than the wires in the 6 x 19 wire rope and, consequently, will not stand as much abrasive wear.

Several factors must be considered whenever a wire rope is selected for use in a particular kind of operation. The manufacture of a wire rope which can withstand equally well all kinds of wear and stress, it may be subjected to, is not possible. Because of this, selecting a rope is often a matter of compromise, sacrificing one quality to have some other more urgently needed characteristic.

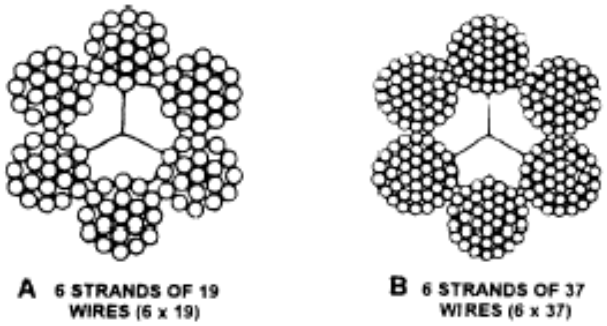


Figure 4-6.
A. 6 x 19 wire rope; B. 6 x 37 wire rope

Tensile Strength

Tensile strength is the strength necessary to withstand a certain maximum load applied to the rope. It includes a reserve of strength measured in a so-called factor of safety.

Crushing Strength
Crushing strength is the strength necessary to resist the compressive and squeezing forces that distort the cross section of a wire rope, as it runs over sheaves, rollers, and hoist drums when under a heavy load. Regular lay rope distorts less in these situations than lang lay.

Fatigue Resistance
Fatigue resistance is the ability to withstand the constant bending and flexing of wire rope that runs continuously on sheaves and hoist drums. Fatigue resistance is important when the wire rope must run at high speeds. Such constant and rapid bending of the rope can break individual wires in the strands. Lang lay ropes are best for service requiring high fatigue resistance. Ropes with smaller wires around the outside of their strands also have greater fatigue resistance, since these strands are more flexible.

Abrasion Resistance
Abrasion resistance is the ability to withstand the gradual wearing away of the outer metal, as the rope runs across sheaves and hoist drums. The rate of abrasion depends mainly on the load carried by the rope and its running speed. Generally, abrasion resistance in a rope depends on the type of metal of which the rope is made and the size of the individual outer wires. Wire rope made of the harder steels, such as improved plow steel, have considerable resistance to abrasion. Ropes that have larger wires forming the outside of their strands are more resistant to wear than ropes having smaller wires that wear away more quickly.

Corrosion Resistance
Corrosion resistance is the ability to withstand the dissolution of the wire metal that results from chemical attack by moisture in the atmosphere or elsewhere in the working environment. Ropes that are put to static work, such as guy wires, may be protected from corrosive elements by paint or other special dressings. Wire rope may also be galvanized for corrosion protection. Most wire ropes used in crane operations must rely on their lubricating dressing to double as a corrosion preventive.

MEASURING WIRE ROPE

Wire rope is designated by its diameter in inches, as shown in figure 4-7. The correct method of measuring the wire rope is to measure from the top of one strand to the top of the strand directly opposite it. The wrong way is to measure across two strands side by side. To ensure an accurate measurement of the diameter of a wire rope, always measure the rope at three places, at least 5 feet apart. Use the average of the three measurements as the diameter of the rope.

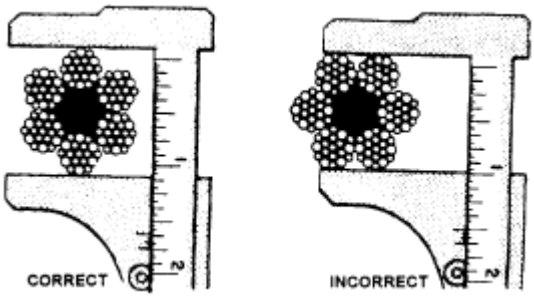


Figure 4-7. Correct and incorrect methods of measuring wire rope

NOTE: A crescent wrench can be used as an expedient means to measure wire rope.

WIRE ROPE SAFE WORKING LOAD

The term *safe working load* (SWL) of wire rope means the load that can be applied and still obtain the most efficient service and also prolong the life of the rope. The formula for computing the SWL of a wire rope is the diameter of the rope squared, multiplied by 8. In mathematical terms: (D x D x 8 = SWL in tons).

Example: The wire rope is 1/2 inch in diameter. Compute the SWL for the rope.

The first step is to convert the 1/2 into decimal number by dividing the bottom number of the fraction into the top number of the fraction: (1 divided by 2 = .5). Next, compute the SWL formula: (.5 x .5 x 8 = 2 tons). The SWL of the 1/2-inch wire rope is 2 tons.

NOTE: DO NOT downgrade the SWL of wire rope due to being old, worn, or in poor condition. Wire rope in these conditions should be cut up and discarded.

WIRE ROPE FAILURE

Some of the common causes of wire rope failure are the following:

Using incorrect size, construction, or grade.

Dragging over obstacles.

Lubricating improperly.

Operating over sheaves and drums of inadequate size.

Overriding or cross winding on drums.

Operating over sheaves and drums with improperly fitted grooves or broken flanges.

Jumping off sheaves.

Exposing to acid or corrosive liquids or gases.

Using an improperly attached fitting.

Allowing grit to penetrate between the strands, promoting internal wear.

Subjecting to severe or continuing overload.

Using an excessive fleet angle.

HANDLING AND CARE OF WIRE ROPE

To render safe, dependable service over a maximum period of time, you should take good care and upkeep that is necessary to keep the wire rope in good condition. Various ways of caring for and handling wire rope are listed below.

Coiling and Uncoiling

Once a new reel has been opened, it may be coiled or faked down, like line. The proper direction of coiling is **counterclockwise** for **left lay** wire rope and **clockwise** for **right lay** wire rope. Because of the general toughness and resilience of wire, it tends now and then to resist being coiled down. When this occurs, it is useless to fight the wire by forcing down the turn because it will only spring up again. But if it is thrown in a back turn, as shown in figure 4-8, it will lie down properly. A wire rope, when faked down, will run right off, like line; but when wound in a coil, it must always be unwound.

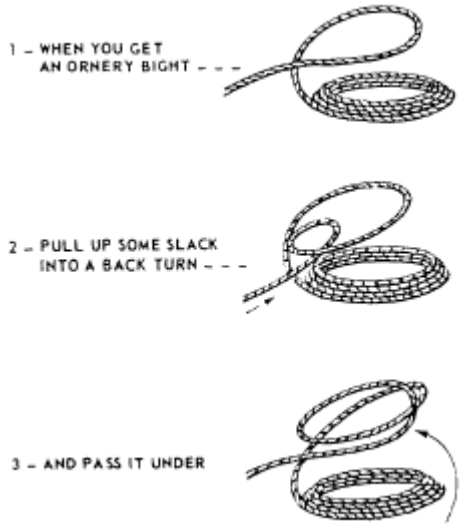


Figure 4-8. Throwing a back turn

Wire rope tends to kink during uncoiling or unreeling, especially if it has been in service long. A kink can cause a weak spot in the rope that wears out quicker than the rest of the rope.

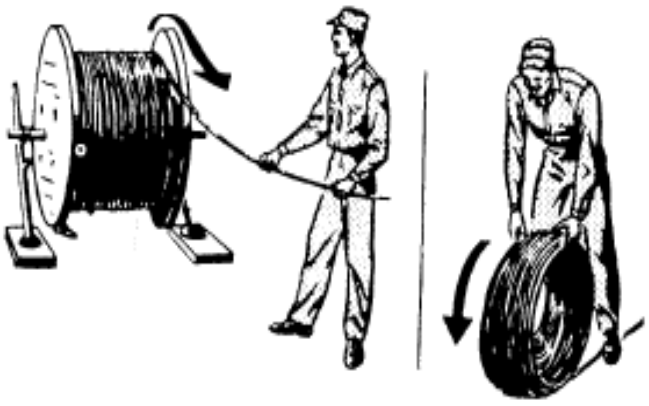


Figure 4-9. Unreeling wire rope (left); uncoiling wire rope (right)

A good method for unreeling wire rope is to run a pipe, or rod, through the center and mount the reel on drum jacks or other supports so the reel is off the ground, as shown in figure 4-9. In this way, the reel will turn as the rope is unwound, and the rotation of the reel helps keep the rope straight. During unreeling, pull the rope straightforward, and avoid hurrying the operation. As a safeguard against kinking, NEVER unreel wire rope from a reel that is stationary.

To uncoil a small coil of wire rope, simply stand the coil on edge and roll it along the ground like a wheel, or hoop, as also shown in figure 4-9. NEVER lay the coil flat on the floor or ground and uncoil it by pulling on the end, because such practice can kink or twist the rope.

Kinks

One of the most common forms of damage resulting from improper handled wire rope is the development of a kink. A kink starts with the formation of a loop, as shown in figures 4-10 and 4-11. A loop that has not been pulled tight enough to set the wires or strands of the rope into a kink can be removed by turning the rope at either end in the proper direction to restore the lay, as shown in figure 4-12. If this is not done and the loop is pulled tight enough to cause a kink (fig. 4-13), the kink will result in irreparable damage to the rope (fig. 4-14).

Kinking can be prevented by proper uncoiling and unreeling methods and by the correct handling of the rope throughout its installation.

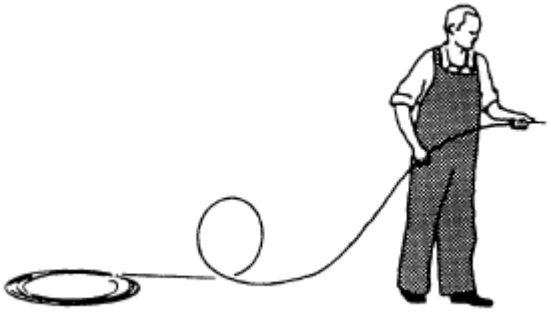


Figure 4-10. Improper handling

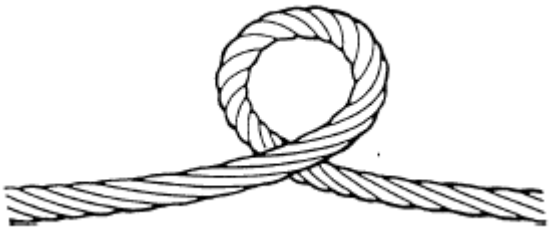


Figure 4-11. Wire rope loop

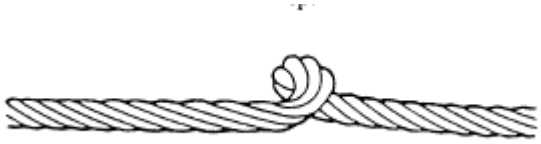


Figure 4-13. Wire rope kink

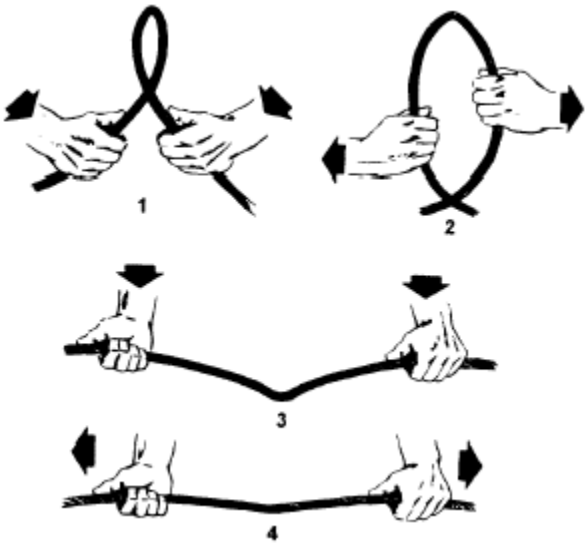


Figure 4-12. Correct way to take out a loop in a wire rope

Figure 4-14 Kink damage

Drum Winding

Spooling wire rope on a crane hoist drum causes a slight rotating tendency of the rope due to the spiral lay of the strands. Two types of hoist drums used for spooling wire rope are as follows:

1. Grooved drum. When grooved drums are used, the grooves generally give sufficient control to wind the wire rope properly, whether it is right or left lay rope.

2. Smooth-faced drum. When smooth-faced drums are used, where the only other influence on the wire rope in winding on the first layer is the fleet angle, the slight rotational tendency of the rope can be used as an advantage in keeping the winding tight and uniform.

NOTE: Using the wrong type of wire rope lay causes the rotational tendency of the rope to be a disadvantage, because it results in loose and nonuniform winding of the rope on the hoist drum.

Figure 4-15 shows drum winding diagrams for selection of the proper lay of rope. Standing behind the hoist drum and looking toward an oncoming over wind rope, the rotating tendency of right lay rope is toward the left; whereas, the rotating tendency of a left lay rope is toward the right.

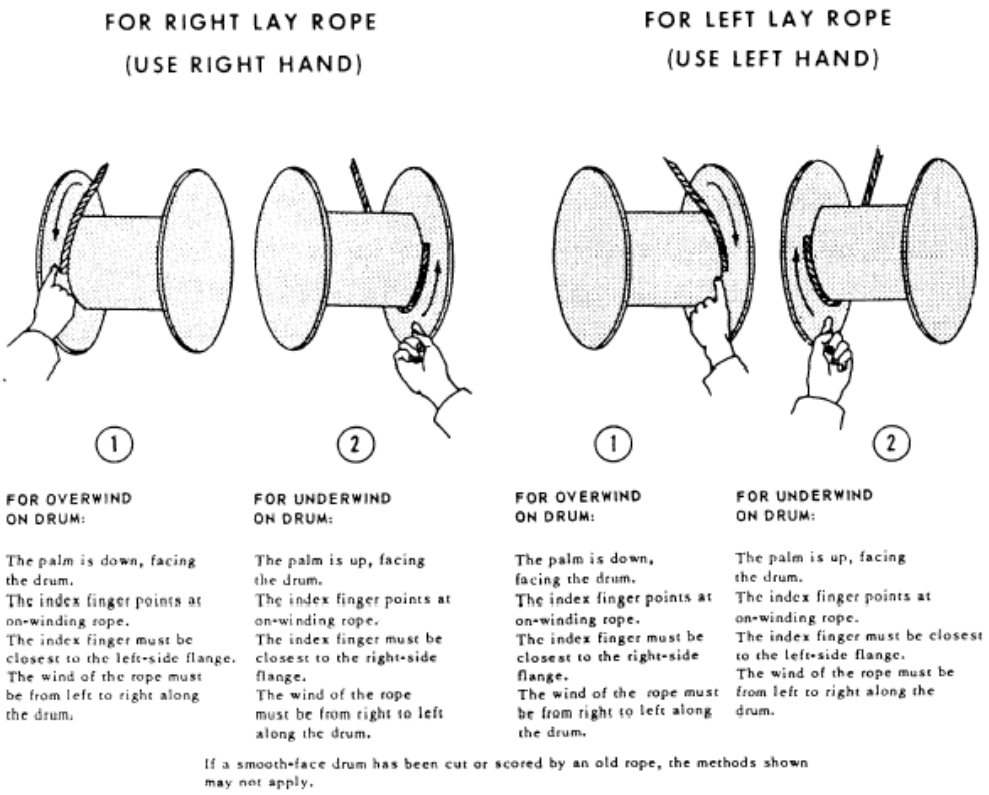


Figure 4-15. Different lays of wire rope winding on hoist drums

Refer to figure 4-15. With over wind reeving and a right lay rope on a smooth-faced drum, the wire rope bitter end attachment to the drum flange should be at the left flange. With under wind reeving and a right lay rope, the wire rope bitter end attachment should beat the right flange.

When wire rope is run off one reel onto another or onto a winch or drum, it should be run from **TOP TO TOP** or from **BOTTOM TO BOTTOM,** as shown in figure 4-16.

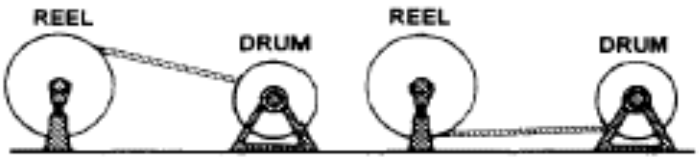


Figure 4-16. Transferring wire rope from reel to drum

Fleet Angle
The fleet angle is formed by running wire rope between a sheave and a hoist drum whose axles are parallel to each other, as shown in figure 4-17.

NOTE: Too large a fleet angle can cause the wire rope to climb the flange of the sheave and can also cause the wire rope to climb over itself on the hoist drum.

Sizes of Sheaves
The diameter of a sheave should never be less than 20 times the diameter of the wire rope. An exception is 6 x 37 wire for which a smaller sheave can be used, because this wire rope is more flexible. The chart shown in table 4-1 can be used to determine the minimum sheave diameter for wire rope of various diameters and construction.

Reverse Bends
Whenever possible, drums, sheaves, and blocks used with wire rope should be placed to avoid reverse or S-shaped bends. Reverse bends cause the individual wires or strands to shift too much and increase wear and fatigue. For a reverse bend, the drums and blocks affecting the reversal should be of a larger diameter than ordinarily used and should be spaced as far apart as possible.

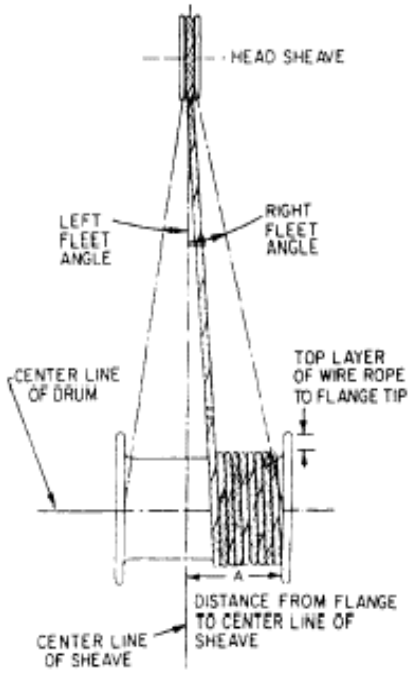


Figure 4-17. Fleet angle relationship

Table 4-1. Suggested minimum tread diameter of sheaves and drums

Rope diameter in inches	Minimum tread diameter in inches for given rope construction*			
	6 x 7	6 x 19	6 x 37	8 x 19
1/4	10 1/2	8 1/2	---	6 1/2
3/8	15 3/4	12 3/4	6 3/4	9 3/4
1/2	21	17	9	13
5/8	26 1/4	21 1/4	11 1/4	16 1/4
3/4	31 1/2	25 1/2	13 1/2	19 1/2
7/8	36 3/4	29 3/4	15 3/4	22 3/4
1	42	34	18	26
1 1/8	47 1/4	38 1/4	20 1/2	29 1/4
1 1/4	52 1/2	42 1/2	22 1/2	32 1/2
1 1/2	63	51	27	39

Rope construction

Sheave diameter

*Rope construction is in strands times wires per strand.

Seizing and Cutting

The makers of wire rope are careful to lay each wire in the strand and each strand in the rope under uniform tension. If the ends of the rope are not secured properly, the original balance of tension will be disturbed and maximum service cannot be obtained because some strands can carry a greater portion of the load than others. Before cutting steel wire rope, place seizing on each side of the point where the rope is to be cut (fig. 4-18). A rule of thumb for determining the size, number, and distance between seizing is as follows:

1. The number of seizing to be applied equals approximately three times the diameter of the rope.

Example: 3 x 3/4-inch-diameter rope = 2 1/4 inches. Round up to the next higher whole number and use three seizing.

2. The width of each seizing should be 1 to 1 1/2 times as long as the diameter of the rope.

Example: 1 x 3/4-inch-diameter rope = 3/4 inch. Use a 1-inch width of seizing.

3. The seizing should be spaced a distance equal to twice the diameter of the wire rope.

Example: 2 x 3/4-inch-diameter rope = 1 1/2 inches. Space the seizing 2 inches apart.

A common method used to make a temporary wire rope seizing is as follows:

Wind on the seizing wire uniformly, using tension on the wire. After taking the required number of turns, as shown in step 1, twist the ends of the wires counterclockwise by hand, so the twisted portion of the wires is near the middle of the seizing, as shown in step 2. Grasp the ends with end-cutting nippers and twist up slack, as shown in step 3. Do not try to tighten the seizing by twisting. Draw up on the seizing, as shown in step 4. Again twist up the slack, using nippers, as shown in step 5. Repeat steps 4 and 5 if necessary. Cut ends and pound them down on the rope, as shown in step 6. If the seizing is to be permanent or if the rope is 1 5/8 inches or more in diameter, use a serving bar, or iron, to increase tension on the seizing wire when putting on the turns.

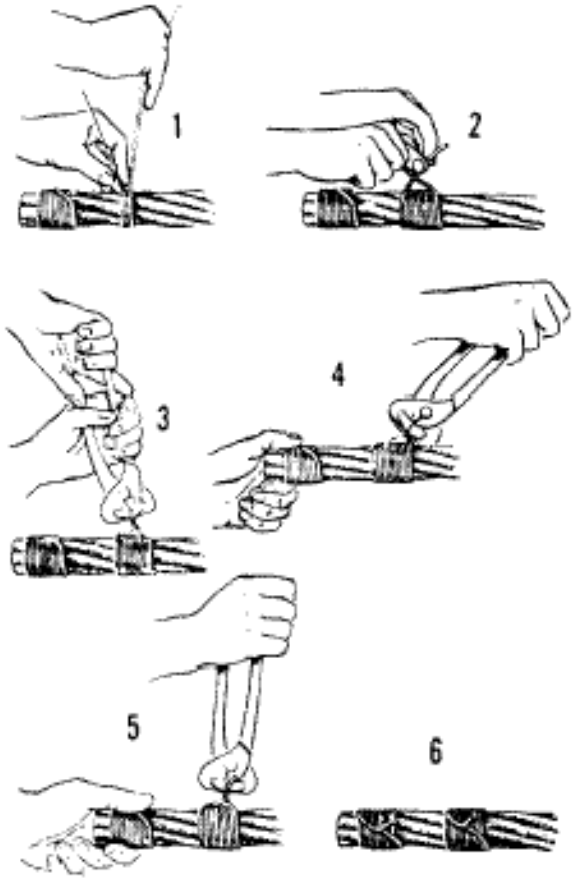


Figure 4-18. Seizing wire rope

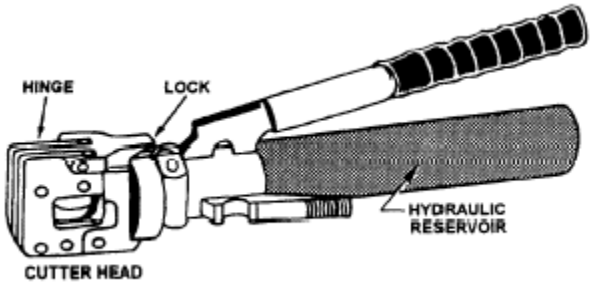


Figure 4-19. Hydraulic type of wire rope cutter

Wire rope can be cut successfully by a number of methods. One effective and simple method is to use a hydraulic type of wire rope cutter, as shown in figure 4-19. Remember that all wire should be seized before it is cut. For best results in using this method, place the rope in the cutter so the blade comes between the two central seizings. With the release valve closed, jack the blade against the rope at the location of the cut and continue to operate the cutter until the wire rope is cut.

MAINTENANCE OF WIRE ROPE

Wire rope bending around hoist drums and sheaves will wear like any other metal article, so lubrication is just as important to an operating wire rope as it is to any other piece of working machinery. For a wire rope to work right, its wires and strands must be free to move. Friction from corrosion or lack of lubrication shortens the service life of wire rope.

Deterioration from corrosion is more dangerous than that from wear, because corrosion ruins the inside wires—a process hard to detect by inspection. Deterioration caused by

wear can be detected by examining the outside wires of the wire rope, because these wires become flattened and reduced in diameter as the wire rope wears.

NOTE: Replace wire rope that has worn one third of the original diameter of the outside wires.

Both internal and external lubrication protects a wire rope against wear and corrosion. Internal lubrication can be properly applied only when the wire rope is being manufactured, and manufacturers customarily coat every wire with a rust-inhibiting lubricant, as it is laid into the strand. The core is also lubricated in manufacturing. Lubrication that is applied in the field is designed not only to maintain surface lubrication but also to prevent the loss of the internal lubrication provided by the manufacturer.

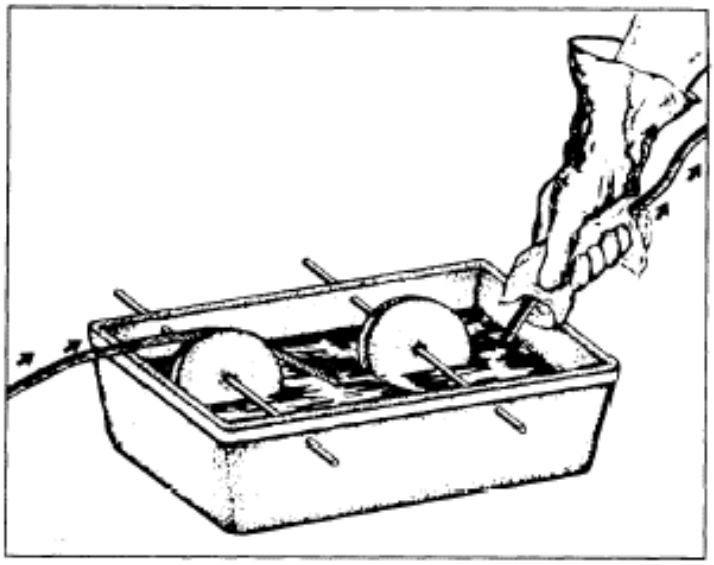


Figure 4-20. Trough method of lubricating wire rope

A lubricant with anti-corrosive should be used to lubricate wire rope. The oil can be applied with a stiff brush, or the wire rope can be drawn through a trough of hot lubricant, as shown in figure 4-20. The frequency of application depends upon service conditions; as soon as the last coating has appreciably deteriorated, it should be renewed.

CAUTION: Avoid prolonged skin contact with oils and lubricants. Consult the Materials Safety Data Sheet (MSDS) on each item before use for precautions and hazards. See your supervisor for copies of MSDSs.

A good lubricant to use when working in the field is a mixture of new motor oil and diesel fuel at a ratio of 70-percent oil and 30-percent diesel fuel. Never lubricate wire rope that works a dragline or other attachments that normally bring the wire rope in contact with soils. The reason is that the lubricant will pick up fine particles of material, and the resulting abrasive action will be detrimental to both the wire rope and sheave.

As a safety precaution, always wipe off any excess oil when lubricating wire rope especially with hoisting equipment. Too much lubricant can get into brakes or clutches and cause them to fail. While in use, the motion of machinery may sling excess oil around over crane cabs and onto catwalks making them unsafe.

NOTE: Properly dispose of wiping rags and used or excess lubricant as hazardous waste. See your supervisor for details on local disposal requirements.

WIRE ROPE ATTACHMENTS

Many attachments can be fitted to the ends of wire rope, so the rope can be connected to other wire ropes, pad eyes, or equipment.

Wedge Socket

The attachment used most often to attach dead ends of wire ropes to pad eyes or like fittings on cranes and earthmoving equipment is the wedge socket, as shown in figure 4-21. The socket is applied to the bitter end of the wire rope.

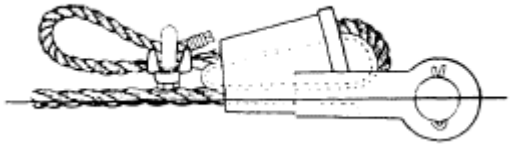


Figure 4-21. Wedge socket

NOTE: The wedge socket develops 70% of the breaking strength of the wire rope due to the crushing action of the wedge.

Speltered Socket

Speltering is the best way to attach a closed or open socket in the field. **"Speltering"** means to attach the socket to the wire rope by pouring hot zinc around it, as shown in figure 4-22. Speltering should only be done by qualified personnel. Forged steel speltered sockets are as strong as the wire rope itself; they are required on all cranes used to lift personnel, ammunition, acids, and other dangerous materials.

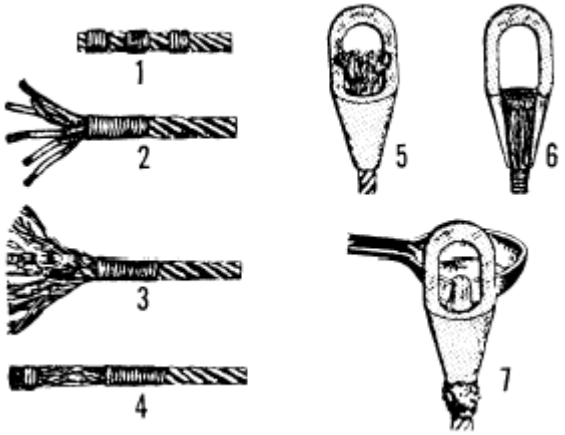


Figure 4-22. Speltering a socket

NOTE: Spelter sockets develop 100% of the breaking strength of the wire rope..

Wire Rope Clips

Wire rope clips are used to make eyes in wire rope, as shown in figure 4-23. The U-shaped part of the clip with the threaded ends is called the **U-bolt;** the other part is called the **saddle.** The saddle is stamped with the diameter of the wire rope that the clip will fit. Always place a clip with the U-bolt on the bitter (dead) end, not on the standing part of the wire rope. If clips are attached incorrectly, the standing part (live end) of the wire rope will be distorted or have mashed spots. A rule of thumb when attaching a wire rope clip is to NEVER saddle a dead horse.

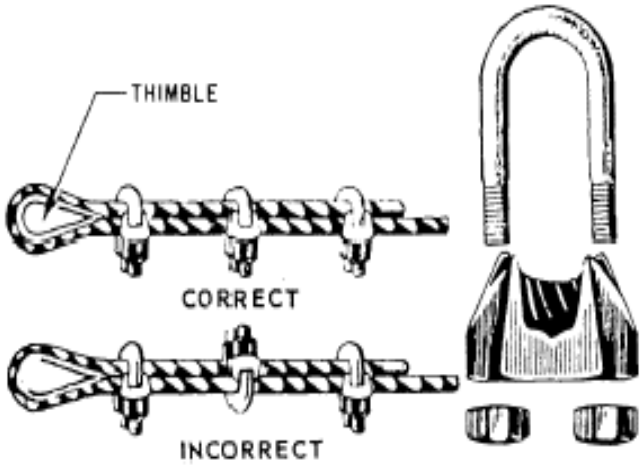


Figure 4-23. Wire rope clips

Two simple formulas for figuring the number of wire rope clips needed are as follows:

3 x wire rope diameter + 1 = Number of clips

6 x wire rope diameter = Spacing between clips

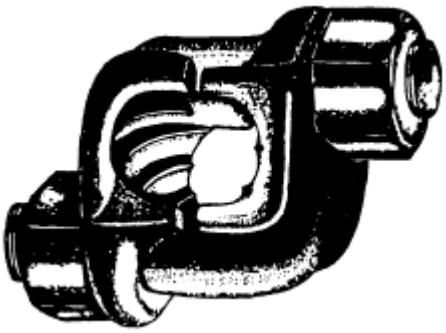


Figure 3-24. Twin-base wire rope clip

Another type of wire rope clip is the twin-base clip, often referred to as the universal or two clamp, as shown in figure 3-24. Both parts of this clip are shaped to fit the wire rope, so the clip cannot be attached incorrectly. The twin-base clip allows for a clear 360-degree swing with the wrench when the nuts are being tightened.

Thimble

When an eye is made in a wire rope, a metal fitting, called a **thimble,** is usually placed in the eye, as shown in figure 4-23. The thimble protects the eye against wear. Wire rope eyes with thimbles and wire rope clips can hold approximately 80 percent of the wire rope strength.

After the eye made with clips has been strained, the nuts on the clips must be retightened. Checks should be made now and then for tightness or damage to the rope caused by the clips.

Swaged Connections

Swaging makes an efficient and permanent attachment for wire rope, as shown in figure 4-25. A swaged connection is made by compressing a steel sleeve over the rope by using a hydraulic press. When the connection is made correctly, it provides 100-percent capacity of the wire rope.

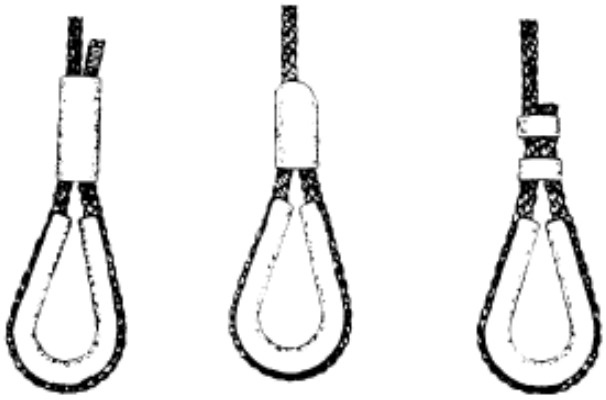


Figure 4-25. Swaged connections

Careful inspection of the wires leading into these connections is important because of the pressure put upon the wires in this section. If one broken wire is found at the swaged connection or a crack in the swage, replace the fitting.

Hooks and Shackles

Hooks and shackles are handy for hauling or lifting loads without tying them directly to the object with a line, wire rope, or chain. They can be attached to wire rope, fiber line, blocks, or chains. Shackles should be used for loads too heavy for hooks to handle.

When hooks fail due to overloading, they usually straighten out and lose or drop their load. When a hook has been bent by overloading, it should NOT be straightened and put back into service; it should be cut in half with a cutting torch and discarded.

Hooks should be inspected at the beginning of each workday and before lifting a full-rated load. If you are not sure a hook is strong enough to lift the load, by all means use a shackle.

Hooks that close and lock should be used where there is danger of catching on an obstruction, particularly in hoisting buckets, cages, or skips, and especially in shaft work. Hooks and rings used with a chain should have about the same strength as the chain.

The manufacturers' recommendations should be followed in determining the safe working loads of the various sizes and types of specific and identifiable hooks. All hooks for which no applicable manufacturers' recommendations are available should be tested to twice the intended safe working load before they are initially put into use.

Mousing is a technique often used to close the open section of a hook to keep slings, straps, and similar attachments from slipping off the hook, as shown in figure 4-26.

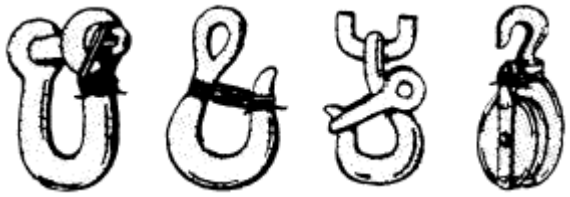


Figure 4-26. Mousing

Hooks may be moused with rope yarn, seizing wire, or a shackle. When using rope yarn or wire, make 8 or 10 wraps around both sides of the hook. To finish off, make several turns with the yarn or wire around the sides of the mousing, and then tie the ends securely.

Two types of shackles used in rigging are the **anchor** (fig. 4-27) and the **chain** (fig. 4-28). Both are available with screw pins or round pins.

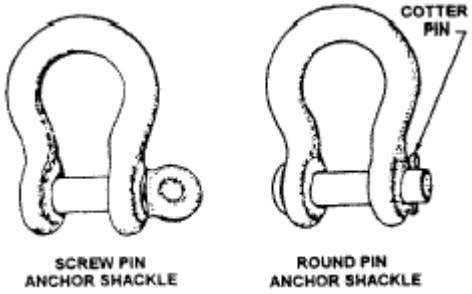


Figure 4-27. Anchor shackles

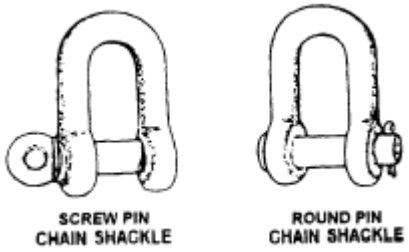


Figure 4-28. Chain shackles

Shackles should be used in the same configuration as they were manufactured. Never replace the shackle pin with a bolt. When the original pin is lost or does not fit properly, do not use the shackle. All pins must be straight and cotter pins must be used or all screw pins must be seated.

A shackle should never be pulled from the side, because this causes the shackle to bend which reduces the capacity tremendously. Always attach a screw pin shackle with the screw pin on the dead end of the rope. If placed on the running end, the movement of the rope may loosen the pin.

Shackles are moused whenever there is a chance of the shackle pin working loose and coming out because of vibration. To mouse a shackle, simply take several turns with seizing wire through the eye of the pin and around the bow of the shackle. Figure 3-26 shows what a properly moused shackle looks like.

FIBER LINE

Fiber line is commonly used to hoist and move heavy loads. Fiber line is constructed similar to wire rope. One difference is yarn. Yarn is used to make the strand in place of wire. Another difference is fiber line does not have a core.

TYPES OF FIBER LINE

The most common types of fiber line are manila, sisal, hemp, cotton, nylon, and Kevlar. The characteristics of these fiber lines are discussed below.

Manila
Manila is a strong fiber that comes from the leaf stems of the stalk of the abaca plant, which belongs to the banana family. The fibers vary in length from 1.2 to 4.5 meters in the natural state. The quality of the fiber and its length give manila rope relatively high elasticity, strength, and resistance to wear and deterioration. In many instances, the manufacturer treats the rope with chemicals to make it more mildew resistant, which increases the quality of the rope. Manila rope is generally the standard item of issue because of its quality and relative strength.

Sisal
Sisal rope is made from two tropical plants that yield a strong, valuable fiber. These plants, sisalana and henequen, produce fibers 0.6 to 1.2 meters long with sisalana producing the stronger fibers of the two plants. Because of the greater strength of sisalana, these fibers are used to make the rope known as sisal. Sisal rope is about 80 percent as strong as high-quality manila rope and can be easily obtained. It withstands exposure to seawater very well and is often used for this reason.

Hemp
Hemp is a tall plant that provides useful fibers for making rope and cloth. Cultivated in many parts of the world, hemp was used extensively before the introduction of manila. Its principal use now is in fittings, such as ratline, marline and spun yarn. Since hemp absorbs tar much better than the hard fibers, these fittings are invariably tarred to make them water resistant. Tarred hemp has about 80 percent of the strength of untarred hemp. Of these tarred fittings, marline is the standard item of issue.

Cotton
Cotton rope is a very smooth white rope that stands much bending and running. Cotton is not widely used. It is sometimes used for small lines.

Nylon
Nylon rope has a tensile strength that is nearly three times that of manila rope. The advantage of using nylon rope is that it is waterproof and has the ability to resume normal length after being stretched and/or absorbing shocks. It also resists abrasion, rot, decay, and fungus

When nylon rope is properly handled and maintained, it should last more than five times longer than manila line subjected to the same use. Nylon rope is also lighter, more flexible, less bulky, and easier to handle and store than manila line. When nylon rope is wet or frozen, it loses little strength. Additionally, nylon line defies mildew, rotting, and attack by marine borers.

Nylon rope can hold a load even when many strands are abraded. Normally, when abrasion is local, the rope may be restored to use by cutting away the chafed section and splicing the ends. Chafing, and stretching do not necessarily affect the load-carrying ability of nylon rope.

The splicing of nylon rope is very similar to that of manila; however, friction tape is used instead of seizing stuff for whipping the strands and line. Because it is smooth and

elastic, nylon requires at least one tuck more than manila. For heavy loads, a back tuck should be taken with each strand.

As with manila, nylon rope is measured by circumference. Nylon, as manila, usually comes on a reel of 600 to 1,200 feet, depending upon the size. Do not uncoil new nylon rope by pulling the ends up through the eye of the coil. Unreel it as you would wire rope. Avoid coiling nylon in the same direction all the time, or you could unbalance the lay.

When nylon rope is stretched more than 40 percent, it is likely to part. The stretch is immediately recovered with a snap back that sounds like a pistol shot.

WARNING

The snapback of a nylon rope can be as deadly as a bullet. Make sure no one stands in the direct line of pull when a heavy strain is applied.

This feature is also true for other types of lines, but overconfidence in the strength of nylon may lead one to underestimate its backlash.

The critical point of loading is 40-percent extension of length; for example, a 10-foot length of nylon rope would stretch to 14 feet when under load. Should the stretch exceed 40 percent, the line will be in danger of parting.

If a nylon rope becomes slippery because of grease, it should be cleaned with a light oil, such as kerosene or diesel oil.

Do not store nylon line in strong sunlight. Cover it with tarpaulins. In storage, keep it away from heat and strong chemicals.

Kevlar

Kevlar is most popularly used to make bulletproof vests and knifeproof gloves. The characteristics of Kevlar line are similar to those of Nylon line except for one significant difference—Kevlar line does not snapback when it parts. This is an important safety feature, since parted nylon line has resulted in numerous deaths due to violent snapbacks.

HANDLING AND CARE OF FIBER LINE

If you expect the fiber line you work with to give safe and dependable service, make sure it is handled and cared for properly. Procedures for handling and caring of fiber line are as follows:

CLEANLINESS is part of the care of fiber line. NEVER drag a line over the ground or over rough or dirty surfaces. The line can easily pickup sand and grit that can work into the strands and wear the fibers. If a line dots get dirty, use water only to clean it. **Do NOT** use soap, because it takes oil out of the line.

AVOID pulling a line over sharp edges because the strands may break. When you have a sharp edge, place chafing gear, such as a board, folded cardboard or canvas, or part of a rubber tire, between the line and the sharp edge to prevent damaging the line.

NEVER cut a line unless you have to. When possible, always use knots that can be untied easily.

Fiber line will contract or shrink if it gets wet. If there is not enough slack in a wet line to permit shrinkage, the line is likely to overstrain and weaken. If a taut line is exposed to rain or dampness, make sure that the line, while still dry, is slackened to allow for the shrinkage.

INSPECTION OF FIBER LINE

Line should be inspected carefully at regular intervals to determine if it is safe. The outside of a line does not show the condition of the line on the inside. Untwisting the strands slightly allows you to check the condition of the line on the inside. Mildewed line gives off a musty odor. A trained observer usually can spot broken strands, or yarns, immediately. You want to look carefully to ensure there is no dirt or sawdust-like material inside the line. Dirt or other foreign matter inside reveals possible damage to the internal structure of the line. A smaller circumference of the line is usually a sure sign that too much strain has been applied to the line.

For a thorough inspection, a line should be examined at several places. After all, only one weak spot, anywhere in a line, makes the entire line weak. As a final check, pull out a couple of fibers from the line and try to break them. **Strong fibers** have a strong resistance to breaking.

If an inspection discloses any unsatisfactory conditions in a line, see that the line is destroyed or cut into small pieces as soon as possible. This precaution prevents the defective line from being used for hoisting.

CHAIN

Typically you should never use a chain when it is possible to use wire rope. The reason for this is because, unlike wire rope, chain does not have reserve strength and does not give any warning that it is about to fail; therefore, you will not be alerted of a potentially hazardous condition.

Chain is better suited than wire rope for some jobs because it is more resistant to abrasion, corrosion, and heat. When chain is used as a sling, it has no flexibility and grips the load well.

CHAIN GRADES

It is difficult to determine the grade of some types of chains by looking at them. If you are uncertain of the class or size of a chain, ask your supervisor.

CHAIN STRENGTH

Before lifting with a chain, make sure the chain is free from twists and kinks. A twisted or kinked chain placed under stress could fail even when handling a light load.

Additionally, ensure that the load is properly seated in the hook (not on the point) and that the chain is free from nicks or other damage. Avoid sudden jerks in lifting and lowering the load, and always consider the angle of lift with a sling chain bridle.

The strength of any chain will be affected when it has been knotted, overloaded, or heated to temperatures above 500°F.

HANDLING AND CARE OF CHAIN

When hoisting heavy metal objects using chain for slings, you should insert padding around the sharp corners of the load to protect the chain links from being cut.

Store chains in a clean, dry place where they will not be exposed to the weather. Before storage, apply a light coat of lubricant to prevent rust.

Do NOT perform makeshift repairs, such as fastening links of a chain together with bolts or wire. When links become worn or damaged, cut them out of the chain, then fasten the two nearby links together with a connecting link. After the connecting link is closed, welding makes it as strong as the other links. For cutting small-sized chain links, use bolt cutters. To cut large-sized links, use a hacksaw.

Inspect the chain to ensure it is maintained in a safe, operating condition. A chain used continuously for heavy loading should be inspected frequently. Chain is less reliable than manila or wire rope slings because the links may crystallize and snap without warning. Examine the chain closely link by link and look for stretch, wear, distortion, cracks, nicks, and gouges. Wear will usually be at the ends of the links where joining links rub together. If you find wear, lift each link and measure its cross section.

NOTE: Remove chains from service when any link shows wear more than 25 percent of the thickness of the metal.

Replace any link that shows cracks, distortion, nicks, or cuts; however, if a chain shows stretching or distortion of more than 5 percent in a five-link section, discard and destroy the entire chain.

Remove chains from service when links show any signs of binding at the juncture points of the links. This condition indicates collapse in the sides of the links has occurred as a result of stretching.

Before lifting with a chain, first place dunnage between the chain and the load to provide a gripping surface. For hoisting heavy metal objects with a chain, always use chafing gear around the sharp corners on the load to protect the chain links from being cut. As chafing gear, use either planks or heavy fabric. In handling rails or a number of lengths of pipe, make a round turn and place the hook around the chain, as shown in figure 4-29.

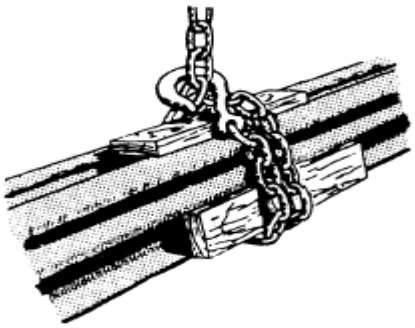


Figure 4-29. Chain sling

SLINGS

Slings are widely used for hoisting and moving heavy loads. Some types of slings come already made. Slings may be made of wire rope, fiber line, or chain.

WIRE ROPE SLINGS

Wire rope slings offer advantages of both strength and flexibility. These qualities make wire rope adequate to meet the requirements of most crane hoisting jobs; therefore, you will use wire rope slings more frequently than fiber line or chain slings.

FIBER LINE SLINGS

Fiber line slings are flexible and protect the finished material more than do wire rope slings. But fiber line slings are not as strong as wire rope or chain slings. Also, fiber line is more likely to be damaged by sharp edges on the material being hoisted than wire rope or chain slings.

CHAIN SLINGS

Chain slings are frequently used for hoisting heavy steel items, such as rails, pipes, beams, and angles. They are also handy for slinging hot loads and handling loads with sharp edges that might cut the wire rope.

USING WIRE ROPE AND FIBER LINE SLINGS

Three types of fiber line and wire rope slings commonly used for lifting a loud are the endless, single leg, and bridle slings.

An **endless sling,** usually referred to by the term **sling,** can be made by splicing the ends of a piece of fiber line or wire rope to form an endless loop. An endless sling is easy to handle and can be used as a **choker hitch** (fig. 4-30).

A **single-leg sling,** commonly referred to as a **strap**, can be made by forming a spliced eye in each end of a piece of fiber line or wire rope. Sometimes the ends of a piece of wire rope are spliced into eyes around thimbles, and one eye is fastened to a hook with a shackle. With this arrangement, the shackle and hook are removable.

Figure 4-30. Endless sling rigged as a choker hitch

The single-leg sling may be used as a choker hitch (fig. 4-31, view A) in hoisting by passing one eye through the other eye and over the hoisting hook. The single-leg sling is also useful as a double-anchor hitch (fig. 4-31, view B). The double-anchor hitch works well for hoisting drums or other cylindrical objects where a sling must tighten itself under strain and lift by friction against the sides of the object.

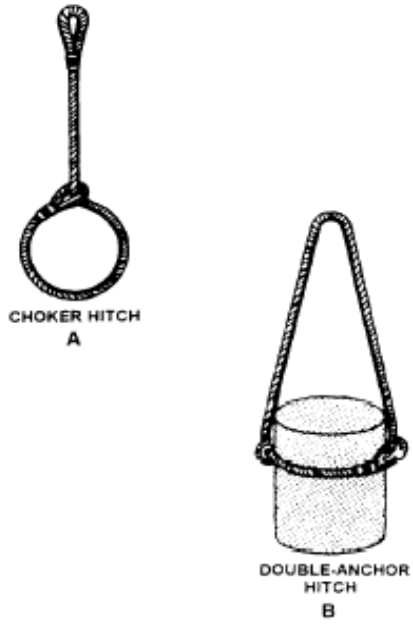


Figure 3-31. Methods of using single-leg slings

Single-leg slings can be used to make various types of **bridles.** Three common uses of bridles are shown in figure 4-32. Either two or more single slings may be used for a given combination. The bridle hitch provides excellent load stability when the load is distributed equally among each sling leg. The load hook is directly over the center of gravity of the load, and the load is raised level. The use of bridle slings requires that the sling angles be carefully determined to ensure that the individual legs are not overloaded.

NOTE: It is wrong to conclude that a three- or four-leg bridle will safely lift a load equal to the safe load on one leg multiplied by the number of legs. This is because there is no way of knowing that each leg is carrying its share of the load.

With a four-legged bridle sling lifting a rigid load, it is possible for two of the legs to support practically the full load while the other two legs only balance it. It is strongly recommended that the rated capacity for two-leg bridle slings be used as the safe working load for three-or four-leg bridle hitches.

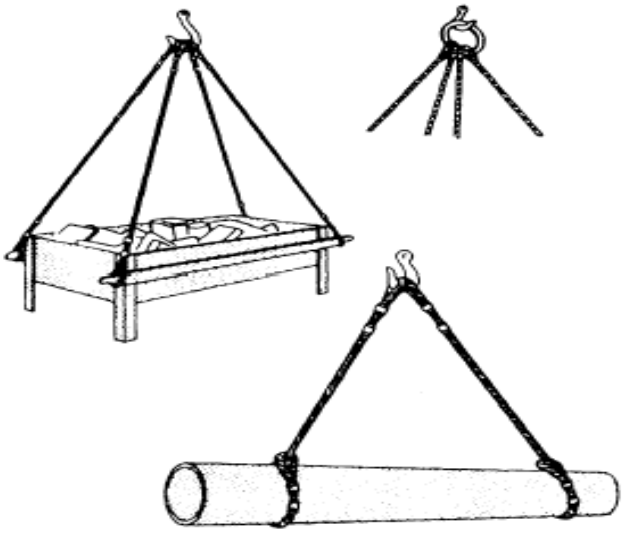


Figure 4-32. Multi-legged bridle slings

When lifting heavy loads, you should ensure that the bottom of the sling legs is fastened to the load to prevent damage to the load. Many pieces of equipment have eyes fastened to them during the process of manufacture to aid in lifting. With some loads, though, fastening a hook to the eye on one end of each sling leg suffices to secure the sling to the load.

Use a protective pad when a fiber line or wire rope sling is exposed to sharp edges at the corners of a load. Pieces of wood or old rubber tires are fine for padding.

Sling Angle

When you are using slings, remember that the greater the angle from vertical, the greater the stress on the sling legs. This point is shown in figure 4-33.

The rated capacity of any sling depends on the size, the configuration, and the angles formed by the legs of the sling and the horizontal. A sling with two legs used to lift a

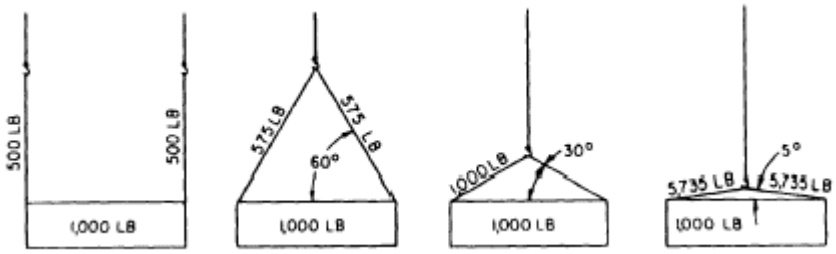


Figure 4-33. Stress on slings at various angles

1,000-pound object will have 500 pounds of the load on each leg when the sling angle is 90 degrees. The load stress on each leg increases as the angle decreases; for example, if the sling angle is 30 degrees when lifting the same 1,000-pound object, the load is 1,000 pounds on each leg. Try to keep all sling angles greater than 45 degrees; sling angles approaching 30 degrees are considered extremely hazardous and must be avoided.

Spreaders Bars

In hoisting with slings, spreader bars are used to prevent crushing and damaging the load. Spreader bars are short bars, or pipes, with eyes fastened to each end. By setting spreader bars in the sling legs above the top of the load (fig. 4-34), you change the angle of the sling leg and avoid crushing the load particularly in the upper portion.

Spreader bars are also used in lifting long or oversized objects to control the sling angle, as shown in figure 4-35. When spreader bars are used, make sure you do not overload the end connection. A spreader bar has a rated capacity that is the same as hooks and shackles. A good rule of thumb is the thickness of the spreaders end connection should be the same as the thickness of the shackle pin.

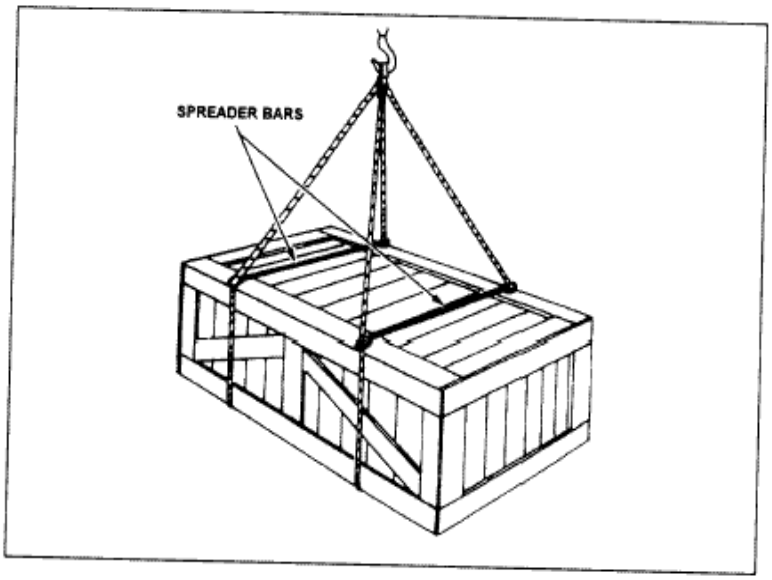


Figure 4-34. Using spreader bars

Sling Safe Working Loads

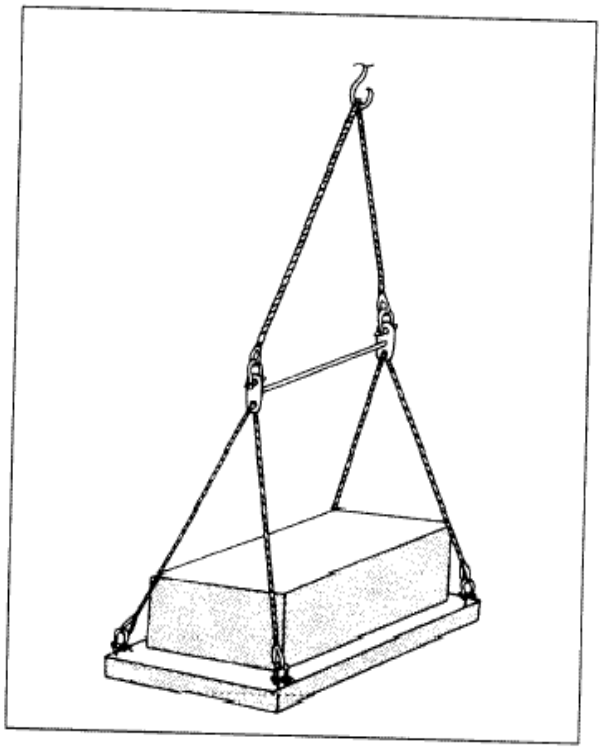


Figure 4-35. Spreader bar used with an oversized load

Formulas for estimating the loads for most sling configurations have been developed. These formulas are based on the safe working load of the single-vertical hitch of a particular sling. The efficiencies of the end fittings used also have to be considered when determining the capacity of the combination.

The formula used to compute the safe working load (SWL) for a **bridle hitch** with two, three, or four legs (fig. 4-36) is SWL (of single-vertical hitch) times H (Height) divided by L (Length) times 2 = SWL. When the sling legs are not of equal length, use the smallest H/L measurement. This formula is for a two-leg bridle hitch, but it is strongly recommended that it also be used for the three- and four-leg hitches.

NOTE: Do NOT forget it is wrong to

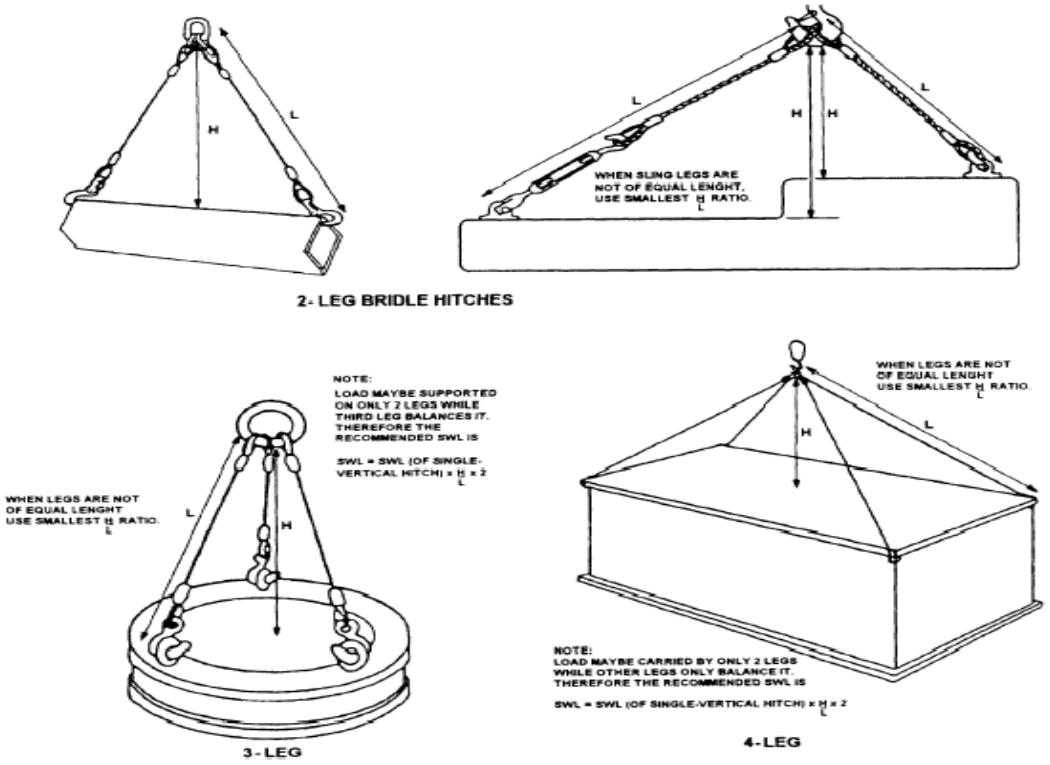


Figure 4-36. Determination of bridle hitch sling capacity

assume that a three- or four-leg hitch can safely lift a load equal to the safe load on one leg multiplied by the number of legs.

Other formulas are as follows:

Single-basket hitch (fig. 4-37): For vertical legs, SWL = SWL (of single-vertical hitch) x 2.

For inclined legs, SWL = SWL (of single-vertical hitch) x H divided by L x 4.

Double-basket hitch (fig. 4-38): For vertical legs, SWL = SWL (of single-vertical hitch) x 4.

For inclined legs, SWL = SWL (of single-vertical hitch) x H divided by L x 4.

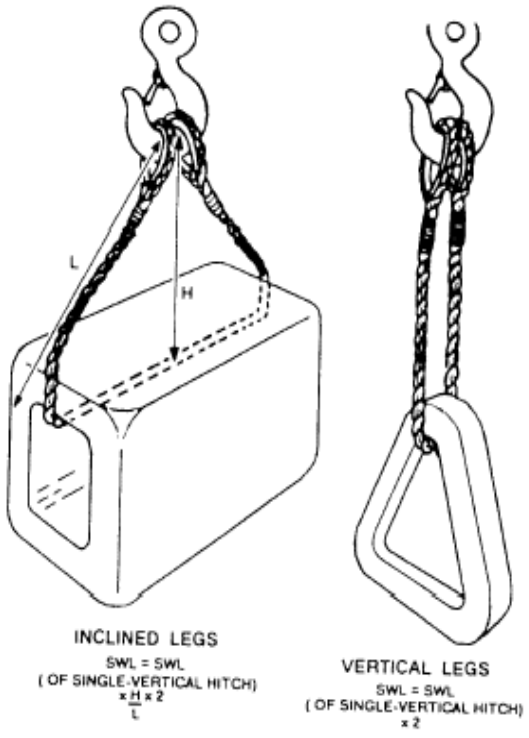


Figure 4-37. Determination of single-basket hitch sling capacity

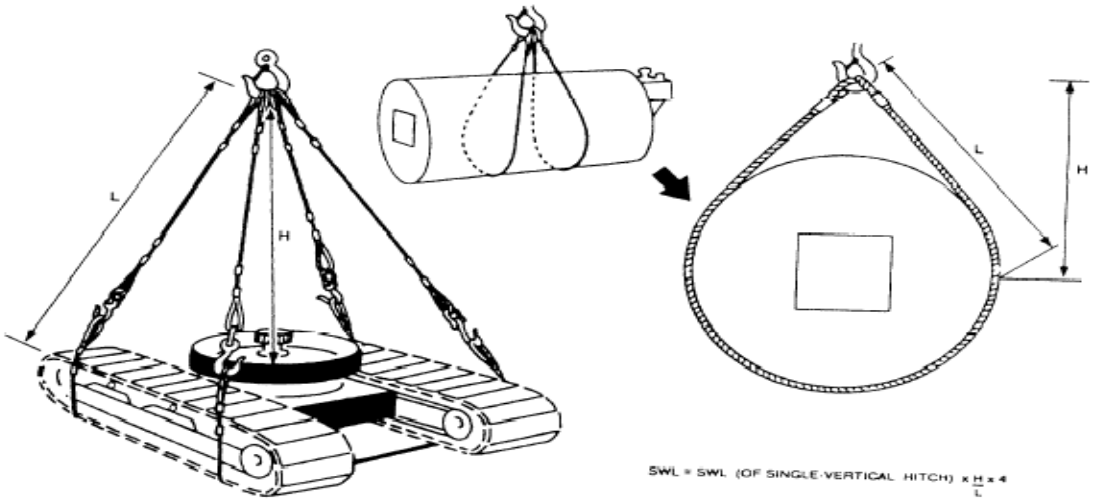
Single-choker hitch (fig. 4-39): For sling angles of 45 degrees or more, SWL = SWL (of single-vertical hitch) x 3/4 or .75.

Sling angles of less than 45 degrees are not recommended; however, if they are used, the formula is SWL = SWL (of single-vertical hitch) x A/B.

Double-choker hitch (fig. 4-40): For sling angle of 45 degrees or more, SWL = SWL (of single-vertical hitch) x 3 divided by 4 x H divided by L x 2.

Sling angles of less than 45 degrees, SWL = SWL (of single-vertical hitch) x A divided by B x H divided by L x 2.

Figure 4-38. Determination of double-basket hitch sling capacity



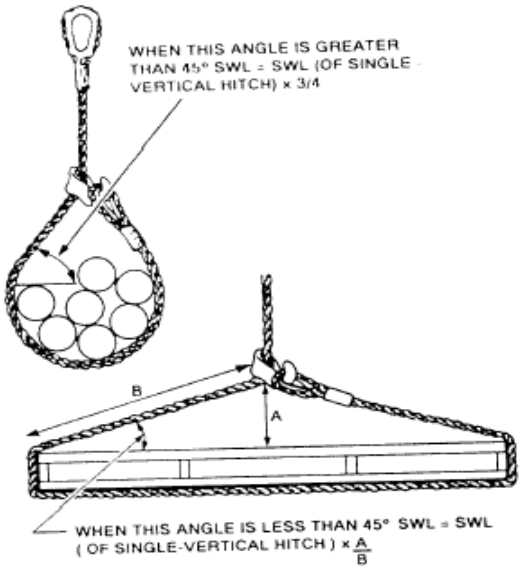


Figure 4-39. Determination of single-chocker hitch sling capacity

Sling Inspection

All slings must be visually inspected for obvious unsafe conditions before each use. A determination to remove slings from service requires experience and good judgment, especially when evaluating the remaining strength in a sling after allowing for normal wear. The safety of the sling depends primarily upon the remaining strength. Wire rope slings must be immediately removed from service if any of the following seven (7) conditions are present:

1. Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one lay

2. Wear or scraping on one third of the original diameter of outside individual wires

3. Kinking, crushing, bird caging, or any other damage resulting in distortion of the wire rope structure

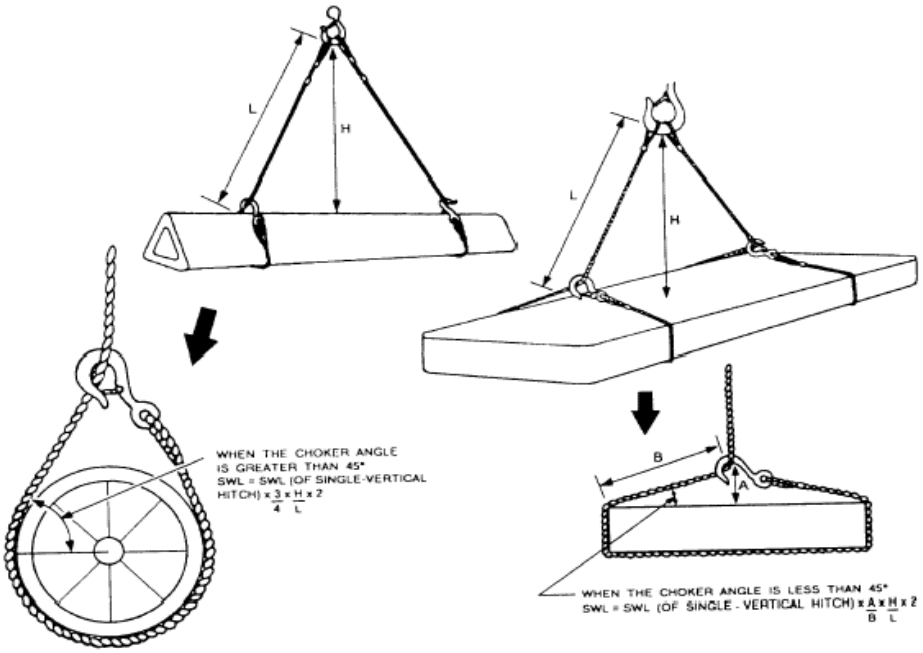


Figure 4-40. Determination of double-choker hitch sling capacity

4. Evidence of heat damage

5. End attachments that arc cracked, deformed, or worn

6. Hooks that have an obviously abnormal (usually 15 percent from the original specification) throat opening, measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook

7. Corrosion of the wire rope sling or end attachments

To avoid confusion and to eliminate doubt, you must not downgrade slings to a lower rated capacity. A sling must be removed from service if it cannot safely lift the load capacity for which it is rated. Slings and hooks removed from service should be cut into pieces, and then disposed. This ensures inadvertent use by another unit.

When a leg on a multiple-leg bridle sling is unsafe, you only have to destroy the damaged or unsafe leg(s). Units that have the capability may fabricate replacement legs in the field, provided the wire rope replacement is in compliance with specifications. Before use, all fabricated slings must be proof-tested.

Spreader bars, shackles, hooks, and so forth, must also be visually inspected before each use for obvious damage or deformation.

Check fiber line slings for signs of deterioration, caused by exposure to the weather. See whether any of the fibers have been broken or cut by sharp-edged objects.

Proof Testing Slings
All field fabricated slings terminated by mechanical splices, sockets, and pressed and

WIRE ROPE SLING PROOF TEST/INSPECTION RECORD

Card ____ of ____ DATE

SLING I.D. NO.

Specification: _____
Length: _____
Cable body diameter: _____
Type splice: _____
Rated capacity (lbs): _____
* Proof test weight (lbs): _____
* Date of proof test: _____ Proof test director sig: _____
Date of inspection: _____ Crane Supv inspector sig: _____
Date of inspection: _____ Crane Supv inspector sig: _____
Date of inspection: _____ Crane Supv inspector sig: _____

REMARKS:

* Applies only to field fabricated slings.

swaged terminals must be proof-loaded before placing the sling in initial service. You must know the diameter, rope construction, type core, grade, and splice on the wire rope sling before referring to charts that list rated capacity for wire rope slings. The charts will give you the vertical-rated capacity for the sling. The test weight for single-leg bridle slings and endless slings is the vertical-rated capacity (V. R. C.) multiplied by two (V.R.C. x 2 = sling test weight). The test load for multiple-leg bridle slings must be applied to the individual legs and must be two times the vertical-rated capacity of a single-leg sling of the same size, grade, and wire rope construction

Records
A card file system, containing a record of each sling in the unit's inventory, should be established and maintained by the crane crew supervisor. Proof Test/Inspection Sheets (fig. 4-41) are used to document tests made on all items of weight-lifting slings, spreader bars, hooks, shackles, and so forth.

These records should be permanent and contain the following entries at a minimum:

1. Sling identification number (unit location and two-digit number with Alfa designation for each wire rope component)

2. Sling length

3. Cable body diameter (inches) and specifications

4. Type of splice

5. Rated capacity

6. Proof test weight

7. Date of proof test

8. Signature of proof test director

Figure 4-41. Proof Test/Inspection Sheet

All the slings must have a permanently affixed, near the sling eye, durable identification tag containing the following information:

1. Rated capacity (in tons) (vert. SWL)

2. Rated capacity (in tons) (45-degree SWL)

3. Identification number

Spreader bars, shackles, and hooks must have the rated capacities and SWL permanent]y stenciled or stamped on them.

Storage
Wire rope slings and associated hardware must be stored either in coils or on reels, hung in the rigging loft, or laid on racks indoors to protect them from corrosive weather and other types of damage, such as kinking or being backed over. Slings should not to be left on the crane at the end of the workday.

WHEEL-MOUNTED CRANE

UNIT 5

HAND SIGNALS

UNIT 5

HAND SIGNALS

People are crippled or killed and enormous property damage is incurred as a direct result of crane mishaps. Most of these crane mishaps result from **OPERATOR ERROR.** Operator error can be reduced if crane operators are properly trained, have qualified assistants, and follow safe operating techniques. Safe operating includes the use of proper crew size and all crew members knowing the standard hand signals.

Crane Crew
The skills and safety standards demanded for efficient crane operations require only mature professionals be assigned as crane operators and riggers. A normal crane crew should consist of three persons. They include a signalman, a rigger, and the crane operator.

Signalman
The signalman is part of the crane crew and is responsible to the operator to give signals for lifting, swinging, and lowering loads. A signalman should be a qualified seasoned crane operator. Not only does the signalman give signals for handling loads, but the signalman can also visually observe what the operator cannot see from the operator's cab. For example, during a lift the signalman should make a visual check of the following:

The load hook is centered over the center of balance of the load, as the weight is being lifted by the crane.

The boom deflection does not exceed the safe load radius.

All the rigging gear is straight and not causing damage to itself or the load.

During a lift with a lattice boom crane, check the boom suspension system and boom hoist reeving to ensure proper operation.

Check the hook block and boom tip sheaves reeving to ensure proper operation.

Check the stability of the outriggers especially when swinging from one quadrant of operation to another.

NOTE: On some cranes, the capacity of the crane changes when swinging from the rear quadrant to over-the-side.

Use tag lines and tag line handlers to prevent the load from swinging or twisting.

WARNING

ALLOWING PERSONNEL TO CONTROL A LOAD BY THE USE OF HANDS PUTS THEM IN GREAT DANGER SHOULD THE LOAD FALL OR SOME UNEXPECTED MISHAP

Signal only to lift the load high enough to clear any obstacles.

ALWAYS have eye-to-eye contact with the crane operator.

The crane operator depends on the signalman to lift, swing, and lower a load safely. The signalman must also know the load weight being lifted and the radius and capacity of the crane. Figures 5-1, 5-2, and 5-3 show the basic hand signals for crane operations. The signalman, crane operator, and rigger all need to know and recognize these basic hand signals.

NOTE: The only time anyone else should give a signal is for an **EMERGENCY STOP.**

Rigger
The rigger or riggers are responsible to the operator for properly attaching the rigging gear to the load. Rigging can be an extremely dangerous job if not properly performed. Safety gear, such as hard hats, steel-toed shoes, gloves, and any other personal safety clothing needed, must be worn.

Riggers and signalman must work closely together after the load is rigged. The signalman visually checks for proper rigging that the operator cannot visually see from the operator's cab. Once the rigging is approved, then the load can be signaled to be lifted.

NOTE: The operator has the final approval on any lift and has the ultimate responsibility for the crane lift and safety.

Operator
The operator pulls the levers on the crane and is directly responsible for the crane, the load rigging, and the lifts performed. The operator must know the crane, how to operate it, how it responds under loaded and unloaded conditions, proper rigging procedures, and signaling.

Hand Signals

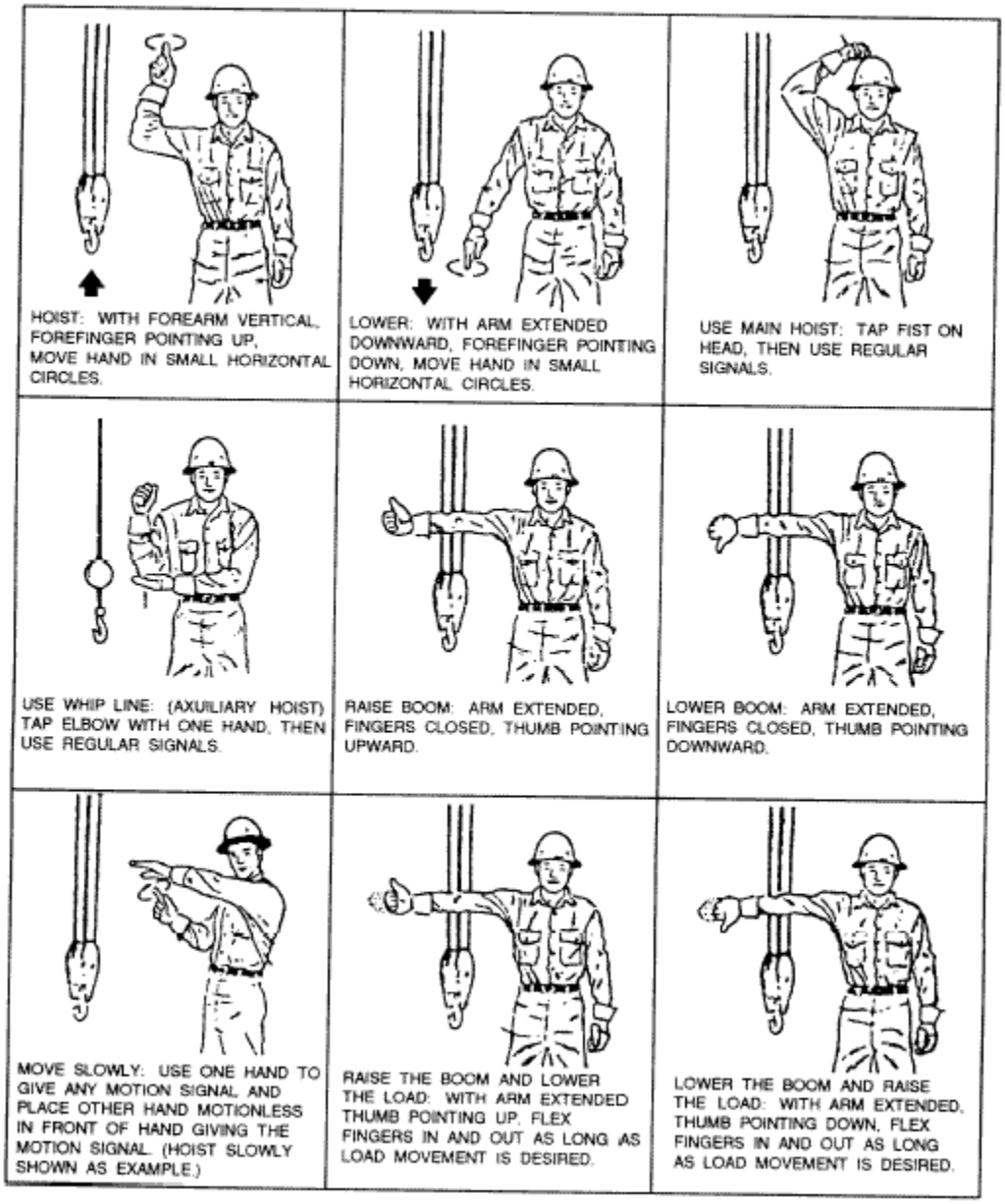


Figure 5-1. Hand signals

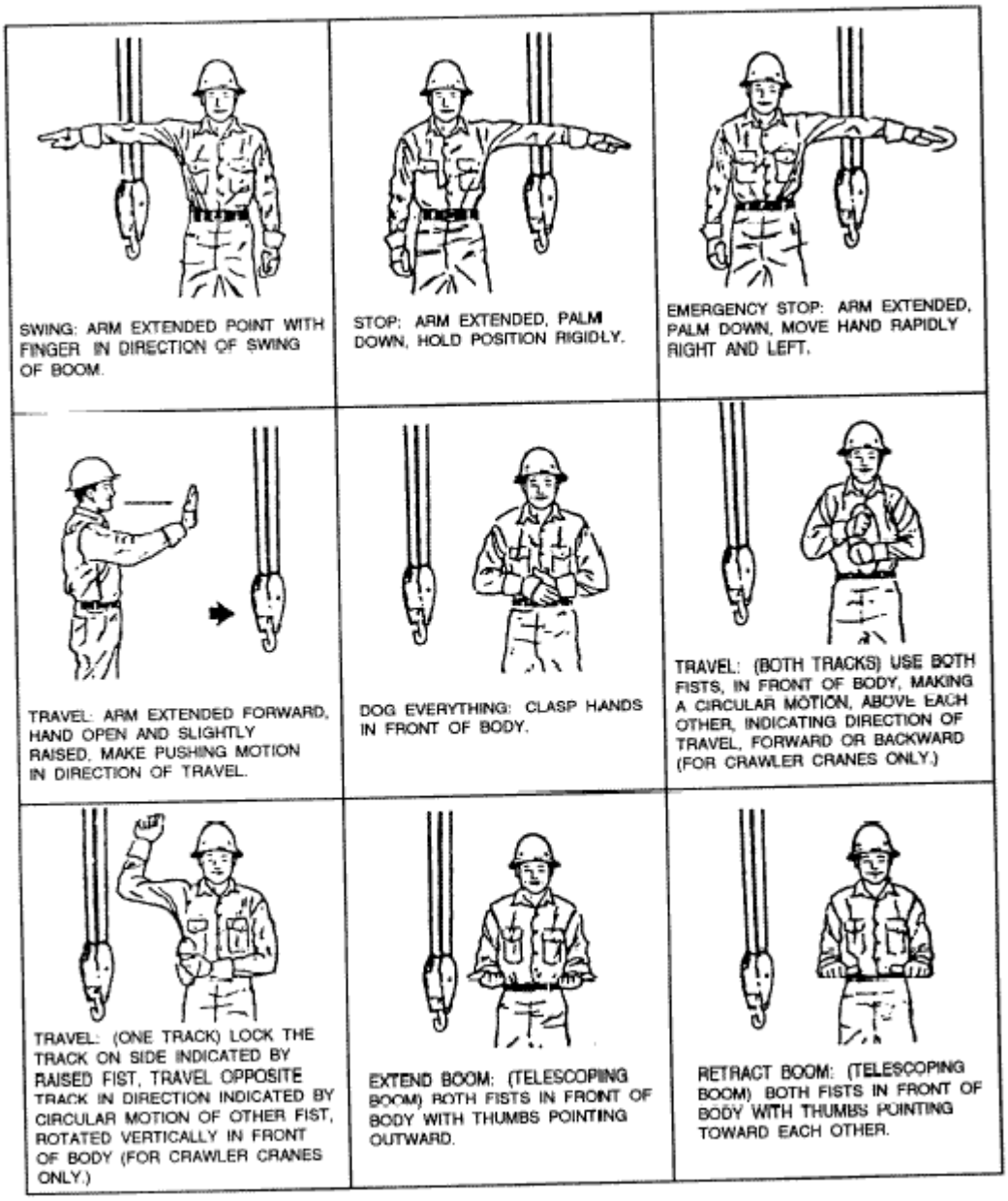


Figure 5-2. Hand signals, continued

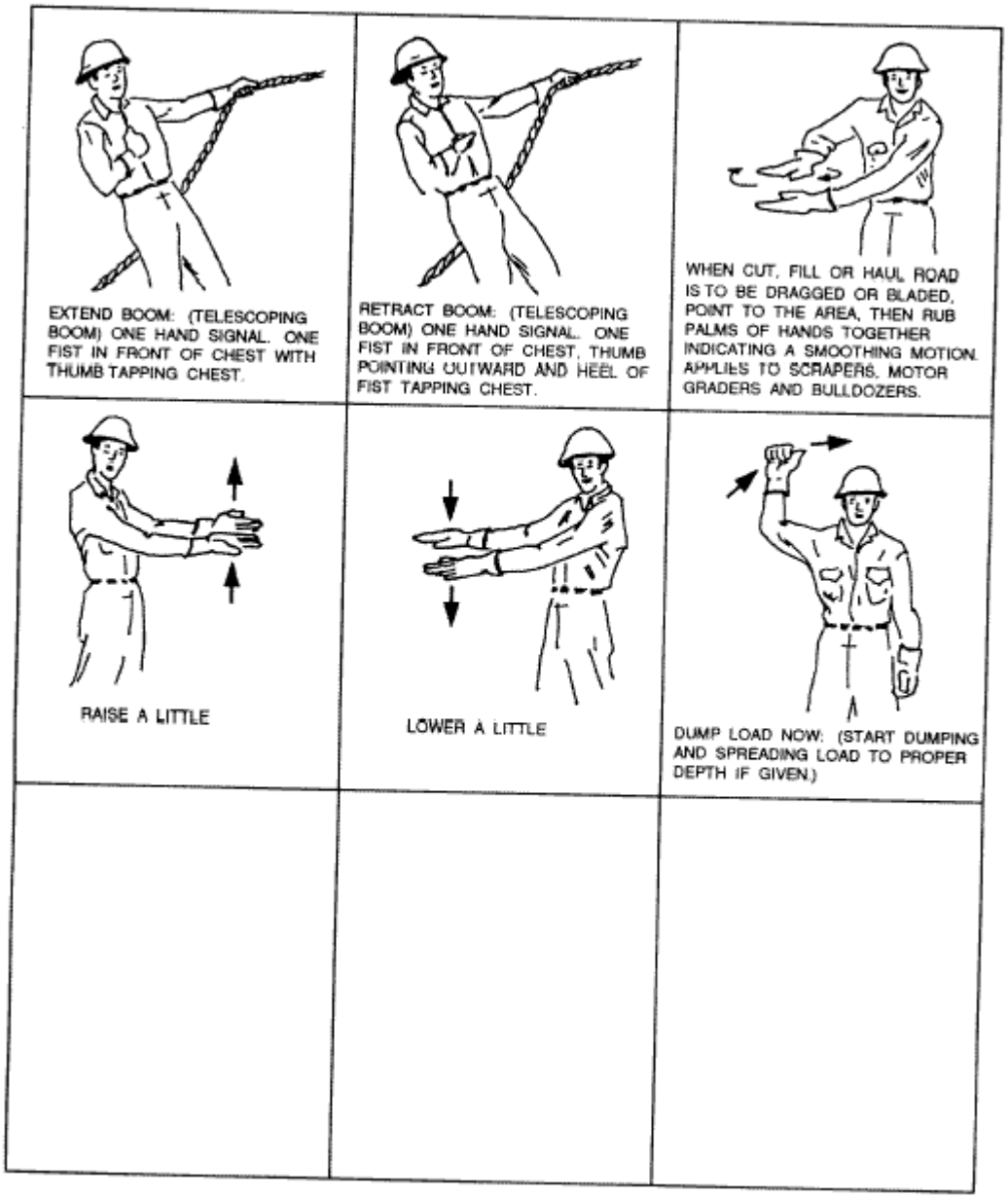


Figure 5-3. Hand signals, continued

WHEEL-MOUNTED CRANE

UNIT 6

CRANE SETUP

UNIT 6

CRANE SETUP

As a crane operator, you must be able to set the crane up properly for lifts. Crane setup involves transporting the crane to the site, establishing proper stability and calculating the load capacity for each lift. The failure to establish crane stability or properly calculate load capacity is a critical error that leads to crane accidents.

Your responsibility as a crane operator is to ensure the crane is stable and that load capacity is properly calculating for each lift operation. Always keep in mind that safety comes first and production second.

Cranes in Transit

Before any crane is moved to a new job-site, the pavements and equipment supervisor and the crane operator need to drive the entire route of travel. They need to ensure that adequate clearances exist along the entire route. It is a good idea to have routes identified for normal transit of the crane. These routes should be designated on a base map and approved for clearances by safety. The empty hook must be secured to prohibit swinging and the boom should be lowered to the boom rest or travel position. A red cloth or warning flag (at least 12 inches square) or a warning light needs to be attached at the end of any boom that extends more than 4 feet beyond the truck platform. At night a warning light (color according to local and state traffic codes) should be used. The superstructure needs to be secured to prohibit rotation except when there is an operator in the cab to ensure proper boom clearances around tight spots and corners. Additional vehicles will be used to warn other motorists if the crane boom or wide load poses a hazard.

Crane Stability

Setting up for a crane lift is the most critical portion of the crane operation. The most common causes of crane mishaps are as follows:

Failure to block/crib under the outrigger pads when poor ground conditions cannot support the total weight of the crane and load. Proper and improper cribbing is shown in figure 6-1.

Failure to extend the outriggers fully and use them according to the manufacturer's instruction.

Failure to note overhead obstructions, such as overpasses and power lines.

Failure to level the crane. Leveling the crane cannot be overemphasized. Cranes must be set up as per manufacturer's instruction with the outriggers fully extended and the crane leveled. Crane capacity is lost when the crane is out of level by only a few degrees (fig. 6-2). Most cranes have levels mounted on them, but the levels are not always accurate. Use a 3-foot builders level to check the level of the crane over the rear and over the sides (fig. 6-3).

Load Capacity

The rated capacities of mobile cranes are based on both **strength** and **stability.** Manufacturers of cranes will normally denote on the load charts a shaded area or a bold line across the chart dividing the lifting capacities based on strength or stability of the crane. It is extremely important to know the difference for, in one case, one of the structural components of the crane will break and, in the other case, the crane will tip over.

Additionally, the following factors must be recognized and the capacity adjusted accordingly:

Do not use stability to determine lifting capacity. Use the load chart installed by the crane manufacturer. The load chart is securely attached in the operator's cab.

The number of parts of line on the hoist and the size and type of wire rope for various crane loads.

Length of boom.

Boom angle.

Boom pendant angle (when the telescopic/ folding gantry is down, the angle decreases and the stress increases).

Gantry and/or live mast in the highest position.

Quadrant of operation (that is, over the side, over the rear capacities). Load capacity does change from quadrant to quadrant.

A typical load rating chart is shown in figure 6-4. To determine the capacity of the crane by using the load chart, the operator must know the length of boom, the load radius, the boom angle, and if the lift is to be performed over the side or over the rear.

When performing lifts using the boom angle indicator that indicates an angle not noted on the load chart, use the next lower boom angle noted on the load chart for determining the capacity of the crane. For example, using the load charts in figure 6-4, the crane is rigged with 60 feet of boom, and the boom angle indicator indicates a boom angle of 57 degrees. A 57-degree boom angle load capacity is not noted on the load chart, so you must use the next lower noted boom angle of 53 degrees for determining the capacity of the crane.

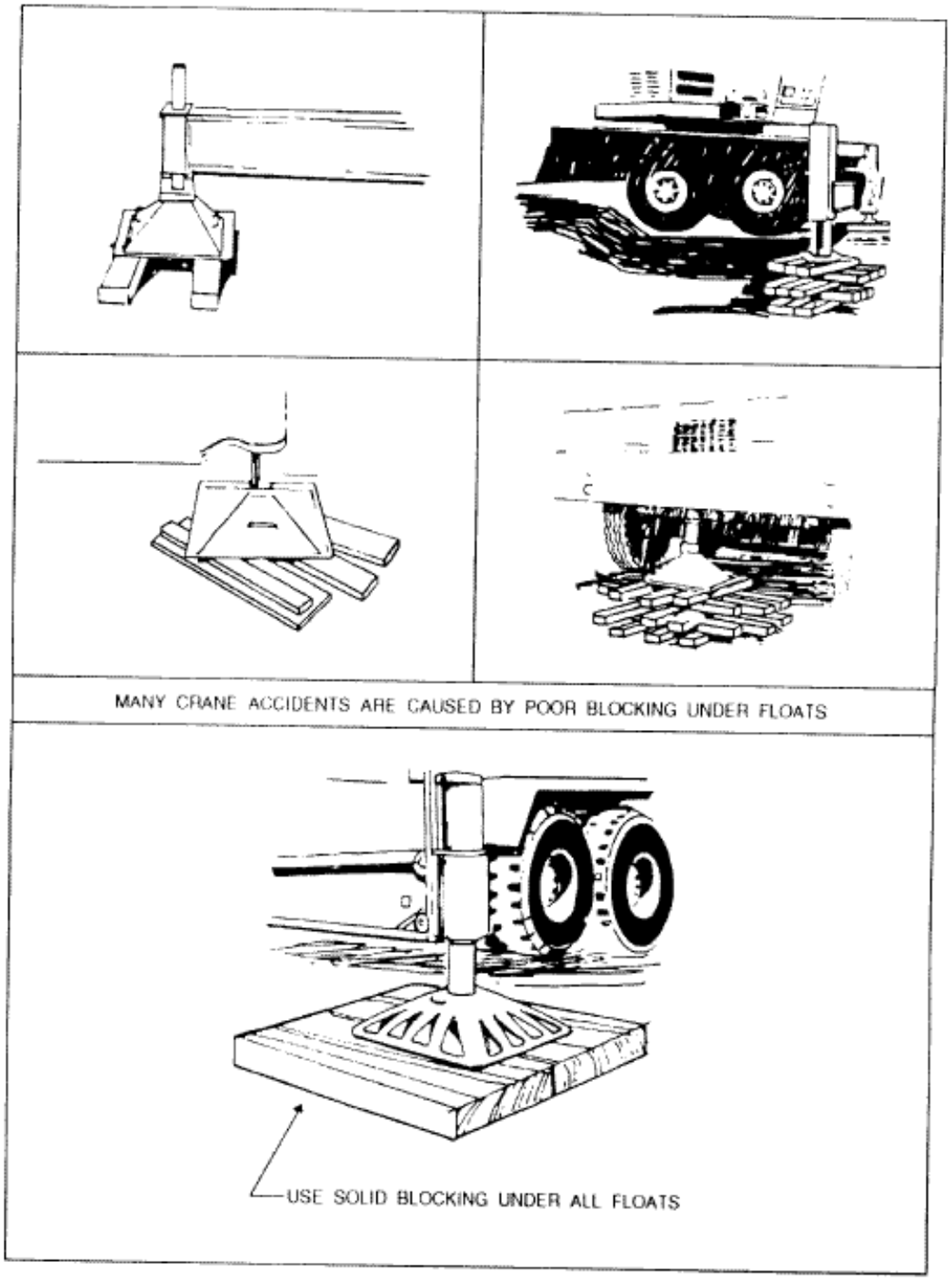


Figure 6-1. Proper and improper cribbing

Boom Length and Lift Radius	Chart Capacity Lost When Crane Out of Level By		
	1°	2°	3°
Short Boom, Minimum Radius	10%	20%	30%
Short Boom, Maximum Radius	8%	15%	20%
Long Boom, Minimum Radius	30%	41%	50%
Long Boom, Maximum Radius	5%	19%	15%

Figure 6-2. Crane capacity lost by crane out of level

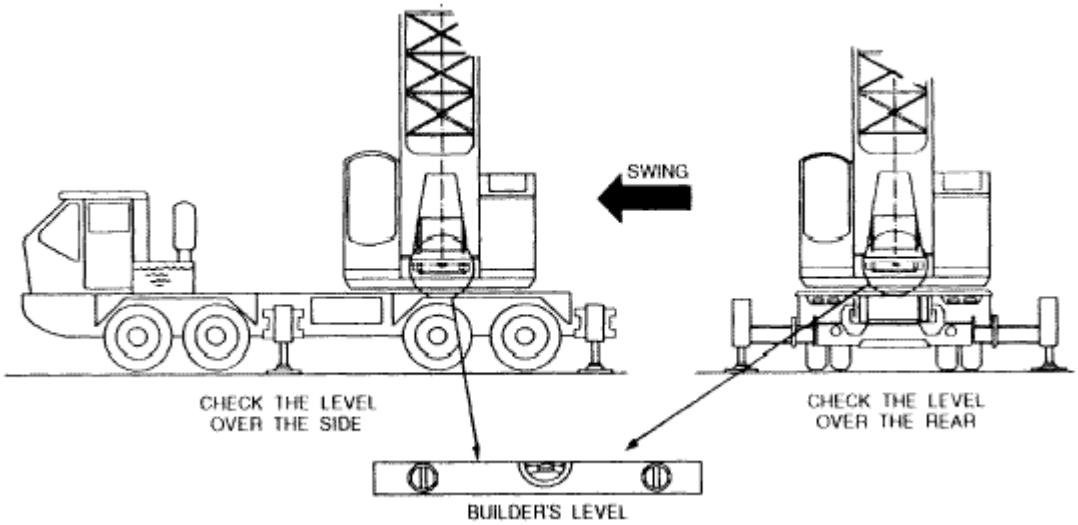


Figure 6-3. Leveling procedures using a builder's level

Load Rating Chart

When using a radius measurement not noted on the load charts, use the next longer radius measurement noted on the load chart for determining the capacity of the crane. For example, using the load charts in figure 12-47, the crane is rigged with 50 feet of boom, and the radius measurement is 32 feet. A 32-foot radius measurement is not noted on the load charts, so you must use the next longer radius measurement of 35 feet noted on the load chart for determining the capacity of the crane.

The number of part lines reeved on the main hoist block can affect the capacity of the crane. If the crane is capable of being reeved with an eight-part line and the reeving is changed to a six-part line, the capacity of the crane changes. On newer models of cranes, the capacity for different parts of line configurations is noted on the load charts. On older models, you must refer to the manufacturer's manual.

The load chart provides the capacity of the crane with outriggers set and without outriggers. "Outriggers set" means the outriggers are fully extended and the weight of the crane is off of the suspension system or the tires are off the ground. If a situation arises where the outriggers cannot be fully extended, you must use the without outriggers load capacity ratings.

NOTE: Load capacities change when swinging from each quadrant of operation, such as from over-the-rear to over-the-side.

MAXIMUM ALLOWABLE LOADS - CRANE SERVICE

BOOM LENGTH IN FEET	LOAD RADIUS IN FEET	BOOM ANGLE IN DEGREES	BOOM POINT PIN HEIGHT	WITH OUTRIGGERS SET*		WITHOUT OUTRIGGERS		
						OVER SIDE		OVER REAR
				OVER SIDE	OVER REAR	8'-0" WIDE	9'-0" WIDE	9' OR 9' WIDE
30	10	78	35'6"	*50,000	*50,000	28,800	32,200	39,300
	12	74	35'0"	*50,000	*50,000	22,500	24,990	30,800
	15	68	34'0"	*50,000	*50,000	16,800	18,500	23,200
	20	57	31'3"	36,800	*43,700	11,700	12,800	16,200
	25	44	27'3"	26,000	31,100	8,800	9,700	12,400
40	12	78	45'3"	*50,000	*50,000	22,200	24,600	30,600
	15	74	44'6"	*50,000	*50,000	16,500	18,200	22,900
	20	66	42'9"	36,600	*41,300	11,400	12,500	16,000
	25	58	40'0"	25,800	30,900	8,600	9,400	12,200
	30	49	36'3"	19,800	23,700	6,800	7,400	9,700
	35	38	30'9"	15,900	19,100	5,500	6,050	8,000
50	15	77	55'0"	*50,000	*50,000	16,400	18,000	22,700
	20	71	53'6"	36,500	*40,000	11,300	12,300	15,800
	25	65	51'6"	25,700	*30,400	8,450	9,250	12,000
	30	58	48'9"	19,600	23,600	6,650	7,250	9,500
	35	51	45'0"	15,800	19,000	5,400	5,900	7,800
	40	43	40'6"	13,100	16,800	4,500	4,900	6,600
	45	34	34'0"	11,200	13,500	3,800	4,150	5,650
60	15	79	65'3"	*48,800	*48,800	16,100	17,800	22,500
	20	74	64'0"	36,400	*39,100	11,000	12,100	15,600
	25	69	62'3"	25,500	*29,600	8,150	8,950	11,800
	30	64	60'0"	19,500	23,400	6,350	7,000	9,300
	35	59	57'3"	15,600	18,800	5,100	5,650	7,600
	40	53	53'9"	13,000	15,700	4,200	4,650	6,400
	45	46	49'6"	11,000	13,300	3,500	3,900	5,350
	50	39	44'3"	9,500	11,600	2,950	3,300	4,700
	55	32	37'9"	8,400	10,200	2,500	2,800	4,000
70	20	77	74'3"	36,200	*37,300	10,700	11,800	15,400
	25	72	73'0"	25,300	*28,800	7,850	8,700	11,600
	30	68	71'0"	19,300	*23,100	6,100	6,700	9,100
	40	59	66'0"	12,800	15,500	3,900	4,350	6,200
	50	49	58'6"	9,350	11,400	2,700	3,000	4,500
	60	36	47'6"	7,200	8,850	1,850	2,150	3,350
80	20	78	84'6"	*32,800	*32,800			
	25	75	83'3"	23,200	*28,400			
	30	71	81'9"	19,100	*22,600			
	40	63	77'6"	12,600	15,300			
	50	55	71'3"	9,200	11,200			
	60	45	62'9"	7,050	8,700			
	70	34	50'9"	5,600	6,950			
90	20	80	94'9"	*29,000	*29,000			
	25	77	93'9"	25,100	*26,000			
	30	73	92'3"	19,000	*22,200			
	40	66	88'6"	12,500	15,200			
	50	59	83'3"	9,050	11,000			
	60	51	76'3"	6,900	8,550			
	70	43	66'9"	5,450	6,800			
	80	32	53'6"	4,400	5,600			
100	20	81	105'0"	*25,300	*25,300			
	30	75	102'9"	18,800	*20,500			
	40	69	99'3"	12,300	15,000			
	50	63	94'9"	8,850	10,800			
	60	56	88'9"	6,700	8,400			
	70	49	81'0"	5,250	6,600			
	80	40	70'6"	4,200	5,350			
	90	30	56'3"	3,350	4,400			
110	20	81	115'0"	*22,000	*22,000			
	30	76	113'0"	*17,700	*17,700			
	40	71	110'0"	12,100	*14,000			
	50	65	106'0"	8,650	10,700			
	60	59	100'6"	6,500	8,200			
	70	53	93'9"	5,050	6,450			
	80	46	85'3"	4,000	5,200			
	90	38	74'3"	3,200	4,250			
	100	29	59'0"	2,600	3,500			

Figure 6-4. Typical crane capacity chart

WHEEL-MOUNTED CRANE

UNIT 7

OPERATING TECHNIQUES

UNIT 7

OPERATING TECHNIQUES

The crane is a versatile piece of equipment. It can be used to lift heavy loads, to load and unload construction materials, and can be used as an aerial work platform. In order to perform these different tasks the crane can be equipped with various attachments. These attachments include a hook block, a clamshell, and a work platform.

Each attachment on the crane requires the operator to know and be able to perform different operating techniques for that attachment.

HOOKBLOCK

With a hook block installed on the crane, its primary purpose is to lift loads and place them where the need to be. A crane to lift almost anything that you can't lift with your hands, so long as it is within the load capacity of that particular crane. It's important to remember that whatever the load, there is proper procedure for lifting, swinging, and placing the load.

Prior to lifting any load, be sure to check the weight of the load against the load chart in the cab. Doing this will prevent you from exceeding the lifting capabilities of the crane. After you've determined the weight, be sure the following are accomplished:

Outriggers are fully extended and firmly positioned on solid surfaces.

The crane is level.

NOTE: The importance of properly leveling a crane cannot be overstressed. A crane that's only slightly out-of-level can quickly encounter a tipping condition..

Brakes are set.

The load is properly rigged and attached to the hook.

Lift the load slightly off the ground and recheck the stability before proceeding with the lift.

If you should encounter a tipping condition, start lowering the load with the hoist line and retract or elevate the boom to bring the load in.

WARNING

NEVER lower or extend the boom when the crane starts to tip. This only aggravates the tipping condition

Lifting

The first step in a lifting operation is to position the boom. To do this, pull back on the boom lift lever and raise the boom. If you happen to get the boom a little too high, push the boom lift lever forward. Once you return the boom lift lever back to the neutral position, the boom will stay at that position. To extend the boom, push the telescope control lever forward away from you. Hold the control in the out position and hold it there until the boom extends to the desired length. To retract the boom, pull back on the telescope control lever until the boom retracts to the desired length. Always keep the boom as short as possible. Swinging loads with a long line can create an unstable condition.

The next step is to hoist the load. To do this, attach the hook block to the load. Then raise the load by pulling the slow speed hoist drum lever back. When you start to lift the load, lift slowly and proceed with caution. Check the hoist brake by raising the load a few inches and holding it there. When the load is stopped at a desired height, the automatic brake will engage and hold the load as long as the control lever remains in neutral. After you've checked the hoist brake, you then hoist the load to the desired height.

Swinging and positioning the load

Before you begin swinging operations, make sure the area in the swing path, as well as the tail swing area, is clear of any obstructions. Remove the turntable lock pin. With the area clear, the lock pin removed and stored, you are now ready to swing the crane with its load. To move the load to the right, push the boom swing lever forward. To move the load to the left, pull back on the boom swing lever. The crane turntable will stop rotating when you move the control lever to the neutral position. This will automatically set the swing brake. Always watch the load and signalman while the load is moving. In case you have to look in another direction, or you lose sight of the load or signalman, stop the operation immediately.

Spotting the load requires accurate control of hoist and swing movements. It takes practice to locate the load at the exact spot without hunting or overshooting. You can raise, lower, extend or retract the boom to make accurate locations of the load. If you have to move the crane to position the load, lower the load to the ground, then reposition the crane.

The slow-speed hoist drum lever is used to lower a load. To do this, push the lever forward. When starting or stopping the hoist, don't jerk the control lever. Jerking the lever causes the load to bounce possibly causing damage to the load or to the crane. Keep in mind to always check the area below the load to be sure it's clear of any obstructions. Once the load is lowered, return the slow speed hoist drum lever to the neutral position. Allow the rigger to disconnect the hook block and any slings used in the lift operation.

Once the load has been released, retract and lower the boom. At the same time you need to raise or reel the cable in to keep it from touching the ground. Also, remember to attach the hook on the front eye of the crane for the proper travel position.

Work Platform
At some point in time you may be asked to provide crane support by attaching the work platform to help other workers complete their task. To do this you will have to know how to attach the work platform to the crane.

WARNING
Never operate crane with this maintenance platform before reading and thoroughly understanding the instructions for its use and the following safety requirements

To prevent serious bodily injury, keep clear of the crane boom while operating the platform

Attach Working Platform

Step 1
Lower the boom to the platform and position the attaching ears in under the tubes on the side of the boom tip.

Step 2
Hang the platform on these ears and install the safety capscrews through the bosses on the ears under the tubes. Secure with locknuts.

Step 3
Attach the cylinder bracket to the ear on the boom tip. Push it up through the hole. Install the locking plate on the spud on the bracket and push it in against the flat surface on the boom head. Add the lockwasher and capscrew to secure the bracket. Tighten to 580 ft. lbs dry or 440 ft. lbs wet.

Step 4
Install rod ends of cylinders in this bracket between the ears. Secure with the pin and lock in place with a capscrew and lockwasher.

Step 5
Remove the hand pump from the toolbox. Check the oil level in the pump reservoir. It should be 1" from the top of the reservoir. If not, fill to the proper level with hydraulic oil the same as used in the crane hydraulic system.

Step 6
Attach the pump to the mounting location on the inside panel of the platform below the valve with two capscrews (fig 7-1.).

Step 7
Connect the hoses from the valve to the pump with the quick disconnects attached to the hoses.

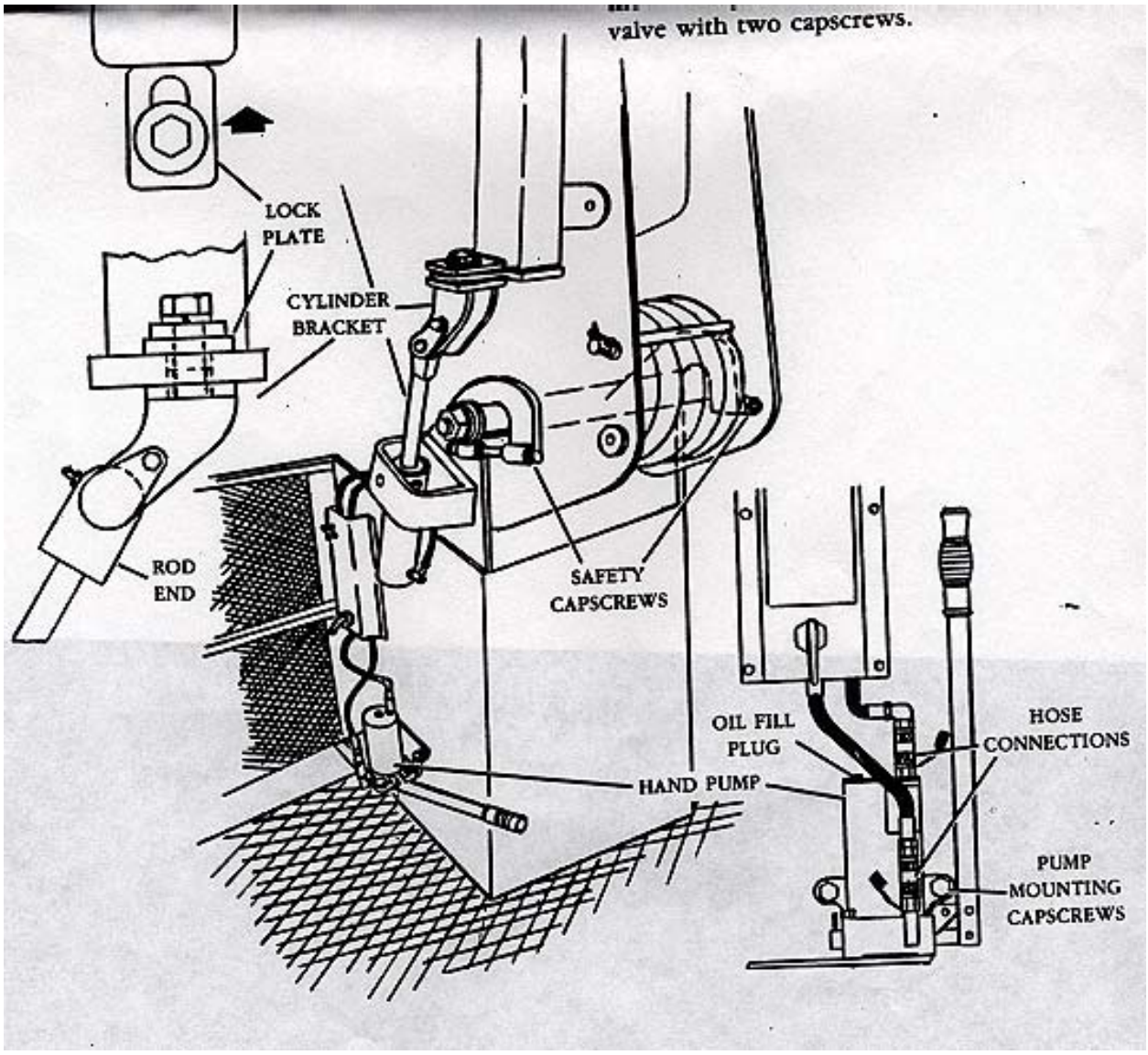


Figure 7-1. Work platform and hand pump (detail)

Level Working Platform
To place the platform in self-leveling mode, rotate the level lock valve counterclockwise 1 to 2 revolutions. The platform should swing freely. The position of personnel and load inside the platform will affect the self-leveling of the platform.

To lock the platform in position; close the level lock valve by rotating it clockwise. The platform should now be locked in position.

Keep the pump in the neutral position when operating the self-leveling valve

With the level lock in the locked (closed) position, select the rotation desired, using the pump direction control valve. With the valve properly positioned, stroke the pump to rotate the platform. When the desired position is obtained, return the valve to the neutral position.

Boom Operation for Work Platform
When the working platform is mounted and used on the crane boom, the two-block counterweight is removed from the clevis on the boom head two-block switch. Without this weight, the switch deactivates the automatic disconnects to the winch hoist, the boom extend and the boom lowering functions. The boom cannot be extended or lowered.

To operate the extend and lowering function when the working platform is mounted on the boom head, install the tethered pin **"A"** in the hole in the switch operating lever.

This pin is to be used only when the working platform is installed on the boom head. The pin must be removed and remain tethered to the platform when it is removed from the boom head.

NOTE: When using the work platform, personnel inside the platform must wear a safety belt, with a lanyard attached, at all times.

CLAMSHELL

The clamshell attachment includes a separate bucket and a boom mounted combination hose and tagline reel, with a separate fairlead assembly.

Preparing the Crane for Clamshell Operation.
Attach the clamshell to the crane using the following steps:

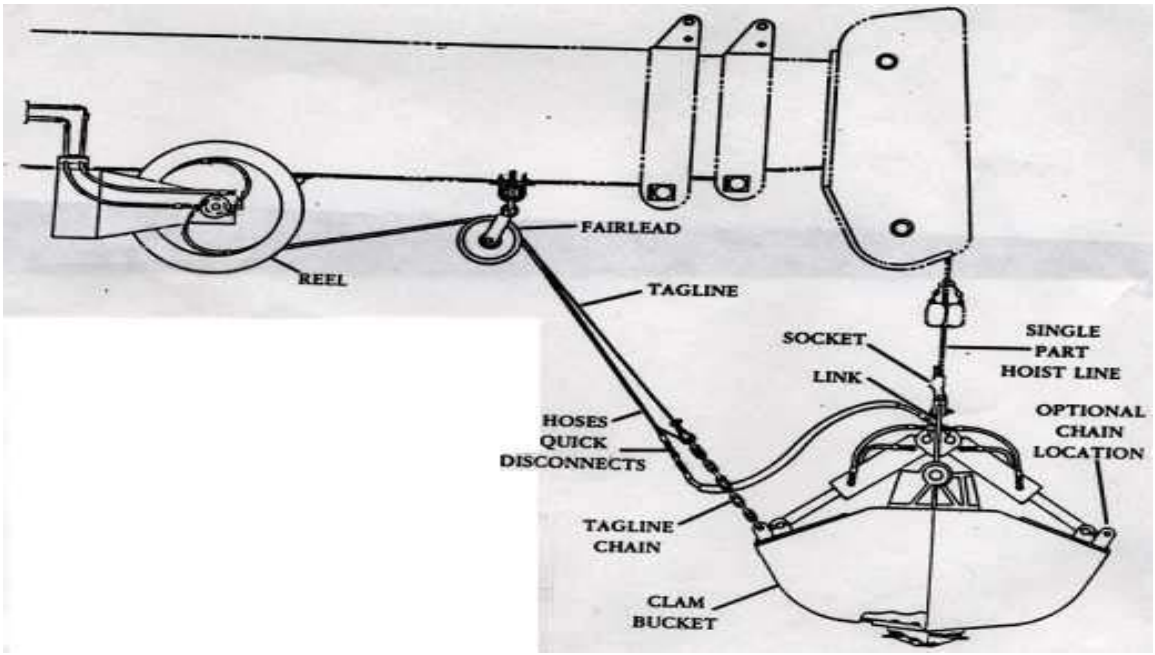
Step 1: Retract and lower the boom to a horizontal position with a single part hoist line reeved over the boom tip.

Step 2: Position the boom tip over the clam bucket. With a cable socket attached to the hoist line, drop it down and attach it to the link on top of the bucket.

Step 3: The tagline cable from the reel is attached to the center of the bucket chain.

Note: The chain can be attached on one clam half or attached to both halves to provide optional clam positions

Step 4: With the quick disconnects, connect the hoses from the reel to the matching hoses on the bucket.



Note: When assembled and correctly adjusted, the tagline cable will carry the load between the reel and the bucket. The hoses should not carry any load, but should not be excessively slack. Refer to the Rudomatic operation and maintenance manual for spring tension adjustment.

Clamshell Operation

Hoisting and lowering the bucket is accomplished with the main winch lever. Lower by pushing the lever forward, and raise by pulling the lever back. Maintain control by operating the engine at medium speed. Move the lever slowly metering the cable movement to prevent "bird caging" the cable on the winch drum. Open and close the bucket with the clam lever. Push to open and pull back to close the bucket. Some cable slack may be created when the bucket closes. Take up this slack with the hoist lever to maintain a slight tension on the hoist line during the digging cycle. Always maintain some tension on the hoist line to keep the cable winding on the drum properly.

CAUTION: The hose reel tagline has an internal shear pin that will break and release the spring tension if the maximum number of spring turns is exceeded. For this application, eleven (11) turns is the maximum number from the neutral position with the cable end retracted to the fairlead or approximately ten (10) from the working position.

Adjustments: Refer to the operators' manual for service and adjustment of the hose and tagline reel.

The clamshell hydraulic circuit is equipped with non-adjustable relief valves that do not require adjustment.

Clamshell Removal: Reverse the attaching procedure by disconnecting the hoses first. Keep them clean by using the caps and plugs provided for the disconnect fittings. Disconnect and secure the tagline. Then lower the bucket to the ground and detach the cable socket from the link on the bucket

WHEEL-MOUNTED CRANE

APPENDIX I

SAMPLE LESSON PLAN

15 – TON WHEEL-MOUNTED CRANE

LESSON PLAN COVER SHEET

Lesson Plan Title: Crane 15 ton wheel mounted crane

Prepared by: _____

Reviewed and Approved/Disapproved by: _____

CES/CC _____ (DATE) _____

WG/LGTM _____ (DATE) _____

WG/LGTO_____ (DATE) _____

WG/LGTO_____ (DATE) _____

COURSE DATA

1. Lesson title: Operators Course for 15 - Ton Wheel Mounted Crane and Attachments.

2. Duration: _____ hours

3. Objective: To train each student with the knowledge and skill necessary to perform pre-start checks and operator's maintenance; transport, position outriggers, lift maximum capacity loads with a hook block, hydraulic clamshell operation and installing the personnel platform. Observing all safety factors with normal supervision. for peacetime and contingency operations.

4. Location of course: _____ Air Force Base, Bldg _____, Training room and equipment yard.

5. Class capacity: Normal 2
Maximum 4
Minimum 2

6. Instructor Requirements: Classroom - 28 hours; Practical - 44 hours

7. Planned course implementation date: When approved by section foreman and technical trainer.

8. Primary mode of training: Group paced.

9. Preceding curriculum outline: None

10. Instruments and procedures for measuring student performance: Written (CerTest) and operator performance test. Criteria on an absolute Pass/Fail basis.

PERSONAL AND PHYSICAL QUALIFICATIONS

1. Eyesight: Applicants must have minimum vision of 20/30 Snellen in one eye and 20/50 Snellen in the other eye, with or without glasses/contact lenses.

2. Color Perception: Applicants must be able to distinguish red, green, and yellow colors regardless of position of colors.

3. Hearing: Applicant's hearing, with or without hearing aid, must test 15/20 for ordinary conversation in one ear.

4. Physical fitness: Applicants must evidence sufficient strength, endurance, agility, and speed of muscular reaction to meet the demands of equipment operations.

5. Physical defects or emotional instability: Not with standing the required physical examination, evidences of physical defects, poor attitude, or emotional instability which would render applicants a hazard to themselves and others,, or which in the opinion of the examiner would interfere with a applicant's safe of efficient performance of duties, are sufficient cause to disqualify an applicant. For an operator who has previously established qualifications to operate, deviations from the physical requirements are not necessarily totally disqualifying. However, where such deviations exist, competent medical and management authorities will give consideration to each individual case and may recommend waivers. Waivers may be approved by CEOH/CEO/CE/LGTM/LGTO.

Waivers will not be granted for applicants who have never before established operator qualifications.

6. Grounds for disqualification: Justification for disqualification of the applicant on the grounds of physical defect or emotional instability may be derived by the examiner from interviews, references to the applicant's medical personnel records, analysis of accident reports involving the applicant, and the results of specialized clinical tests. specialized clinical tests by the examiner any consist of testing the applicant's depth perception, reaction time, field of vision, manual dexterity, tendencies to dizziness, or similar pertinent characteristics.

7. Re-certification: All certified crane operators will be re-certified yearly and given a refresher training course, a crane safety course, and shall pass a written and performance test.

INSTRUCTOR'S REFERENCES

AFOSH 127-10	Civil Engineering
AFOSH 127-46	Materials Handling and Storage Equipment
TO 36-1-5	Rules on Safety
ANSI B30.5	Crawler, locomotive and truck cranes
OSHA 1926	Cranes and Derricks
OSHA 1910	Slings
AFI 24-301	Vehicle Operations
SAE J881	Lifting Crane Sheave and Drum Sizes
SAE J959	Lifting Crane, Wire Rope Strength Factors
SAE J765	Crane Load Stability Test Code
PCSA	(Power Crane and Shovel Association) Standard I, II, III

TRAINING EQUIPMENT LIST

Item(s)	Quantity
Crane 15 ton wheel mounted	1
2-Sheave Hook Block	1
1/2 yard Clamshell	1
Personnel basket	1
Wire rope calipers	1
1/2 inch open end wrench	1
3/4 inch open end wrench	1
10 inch open end adjustable wrench	1
15 inch open end adjustable wrench	1
Pliers 10 inch slip joint	1
Needle point pliers	1
Marlin Spike 16 inch	1
Punch 8 inch	1
Hammer 2 lb.	1
Grease Gun	1
Clips-Crosby Type 9/16 inch	2
Wedge Socket	1
Shackles 1/2, 5/8, 3/4, 1 inch	4 ea.
Sling 6x19x5/8x12' IPS IWRC wire rope	2 ea.
Sling 6x19x5/8x16' IPS IWRC wire rope	2 ea.

Sling 4 leg with master link 6x19x5/8x16' IPS IWRC wire rope	1
Sling 4 leg with master link 6x19x3/4x16' IPS IWRC wire rope	1
Sling 4"x16'x4-Ply nylon web	2 ea.
Rope nylon 1/2 inch x 16 feet	2 ea.
Sheave Gauge	1

MASTER COURSE SCHEDULE

Unit	Type Hours	Title	
0.1	Classroom	Orientation	_____
0.2	Classroom	Safety	_____
1.0	Classroom	Hand Signals	_____
1.1	Classroom	Wire rope Construction and Classification	_____
1.2	Classroom	Rigging and Slings	_____
1.3	Classroom	Pre-operational/Post Operational Procedures	_____
1.4	Classroom	Preventive Maintenance	_____
1.5	Classroom	Travel/Transport Crane	_____
1.6	Classroom	Setting out Riggers	_____
1.7	Classroom	Operate Crane with Hook Block	_____
1.8	Classroom	Operate Crane with Clamshell	_____
1.9	Classroom	Operate Crane with Personnel Basket	_____
2.0	Classroom	Written Test	_____
2.1	Practical	Pre-operational Procedures	_____
2.2	Practical	Pre-operational Check	_____
2.2	Practical	Pre-operational Check	_____
2.3	Practical	Setting out the out riggers	_____
2.4	Practical	Operate Crane with Hook Block	_____
2.5	Practical	Performance Test	_____
2.6	Practical	Pre-check Clamshell	_____
2.7	Practical	Setting Crane with Clamshell	_____
2.8	Practical	Operate Crane with Clamshell	_____
2.9	Practical	Pre-operational Check Personnel Basket	_____
3.0	Practical	Operate Crane with Personnel Basket	_____
3.1	Practical	Hook Block Back on Crane and Load Test	_____

0.1 ORIENTATION

Terminal Objective: Upon completion of this unit, the student will have registered for the training course, know course contents, and know what is expected from the student.

Enabling Objective: The student will be able to answer what the course intends to cover and what the course expects from the students.

LESSON TOPIC GUIDE

0.1 ORIENTATION

1. Introduction:	Instructor Activity:
A. Establish Contact:	Introduce yourself, and give the topic for this lesson.
B. State Lesson Objective	
C. Establish Readiness	
(1). Motivate Students	Use motivating statements
a. Pass course b. Perform better on the job c. Get advanced d. Be a better equipment operator	
2. Lesson Overview	State learning objectives
	a. State information and materials necessary to guide students b. Notes may be taken c. Questions d. Classroom conduct e. Shop area conduct

0.2 SAFETY

Terminal Objective: Upon completion of this unit, the student will have been provided with information regarding Air Force regulations, government directives, squadron written and verbal policies.

Enabling Objective: The student will be able to demonstrate adherence to the safety policies regarding safe handling and the use of occupational equipment and materials, exercising personal safety, avoiding and eliminating fire hazards, and methods of reporting accidents.

Criterion Test: When the student completes this lesson topic, the student will express safety policies of this course regarding handling and use of occupational equipment and materials, exercising personal safety, avoiding and eliminating fire hazards, and methods of reporting accidents.

LESSON TOPIC GUIDE

0.2 SAFETY

I. Introduction:	Instructor Activity
A. Establish contact	Introduce yourself and give topic for his lesson.
B. State lesson objectives	
C. Establish readiness	
1. Motivate students	Use motivating statements.
a. Pass course b. Perform better on job c. Get advanced d. Be a better equipment operator	
2. Lesson overview	State learning objectives.
	a. State information and materials necessary to guide students. b. Notes may be taken. c. Questions. c. Classroom conduct. e. Shop area conduct. f. Short test will be given daily during classroom curriculum.

II. Presentation

A. Safety hazards — State how these items can be hazards

1. Tripping

a, Hand tools
b, Jacks
c, Creepers

2. Slippage

a, Oil and grease
b, Water

3. Eyes

a, Fuel
b, Grinding
c. Wire rope

4. Compressed air

a, Eye and face
b. Skin penetration

5. Fire

a. Fuel
b. Fumes
c. Electrical

6. Hands

a. Cuts
b. Burns
c. Crushing

7. Ears

a. Noise
b. Dirt and grease

8. Head

a. Cuts
b. Grease
c. Blows on the head

9. Avoiding Hazards

    a. Face mask; goggles
    b. Hard hats
    c. Gloves
    d. Hearing protection
    e. Proper storage
    f. Cleanliness

10. Attitude

11. Safety slides and VCR

1.0 HAND SIGNALS

Terminal objective: Upon completion of this unit the student will have answered questions pertaining to all hand signals that are universally used.

Enabling objective: The student will be able to receive and transmit universally used hand signal spontaneous without thinking. The student will also know the proper horn signals.

Criterion Test: When the student completes this lesson, all signals will be demonstrated by each student.

LESSON TOPIC GUIDE

1.0 HAND SIGNALS

I. Introduction	Instructor Activity
A. Establish contact	Introduce yourself and give topic for this lesson.
B. State lesson objective	
C. Establish readiness	
1. Motivate students	
a. Pass course b. Perform better on job c. Get advanced d. Be a better equipment operator	
2. Lesson overview	State learning objectives
	a. State information and materials necessary to guide students. b. Notes may be taken. c. Questions. d. Classroom conduct. e. Shop area conduct. f. Test 100% is mandatory.

II. Presentation

A. Signals

1. Hand signals

2. Crane horn proper signals

B. Explain there are 20 standard hand signals for cranes approved by ANSI and OSHA. Some can be combined.

C. Standard hand signals. Instructor demonstrates each signal as explained.

1. Swing-arm extended, point with finger in direction of swing of boom.

2. Stop-arm extended, palm down, hold position rigidly.

3. Emergency Stop-arm extended, palm down, move hand rapidly right and left.

4. Travel-arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.

5. Dog Everything-clasp hands in front of body.

6. Travel (both tracks)-use both fists in front of body making a circular motion, indicate motion of travel forward or backward (for crawler crane only).

7. Travel (one track)-lock the track on side indicated by raised fist, travel other track in direction indicated by circular motion of other fist. Rotated vertically in front of body (for crawler crane only).

8. Extend Boom-(Telescoping boom) both fists in front of body with thumbs pointing outward.

9. Retract Boom-(Telescoping boom) both fists in front of body with thumbs pointing toward each other.

10. Hoist-with forearm vertical, forefinger pointing up, move hand in a horizontal circle.

11 Lower-with arm extended downward, forefinger pointing down, move hand in a small horizontal circles.

12. Use main hoist-top fist on head, then use regular signal.

13. Use whip line-(Auxiliary hoist) top elbow with on hand, then use regular signals.

14. Raise Boom-arm extended, fingers closed, thumb pointing upward.

15. Lower Boom-arm extended, fingers closed, thumb pointing downward.

16. Move slowly-use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal.

17. Raise the boom and lower the load-with arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.

18. Lower the boom and raise the load-with arm extended, thumb pointing down, flex fingers in and out as long as long movement is desired.

19. Extend Boom-(Telescoping boom) one hand signal, one fist in front of chest with thumb tapping chest.

20. Retract Boom-(Telescoping boom) one hand signal, one fist in front of chest, thumb pointing outward and heel of fist tapping chest.

D. Crane horn proper signals.

1. One blast-stop travel.
2. Two blasts-move carrier or truck ahead.
3. Three blasts-move carrier or truck backward.
4. Series of short blasts - warning to personnel in area.

1.1 WIRE ROPE CONSTRUCTION AND CLASSIFICATION

Terminal Objective: Upon completion of this unit the student will have answered question pertaining to the use and safety of wire rope construction and classification.

Enabling Objective: The student will be able to distinguish wire rope abbreviations, size, strength of wire rope, inspect for defects and proper Sheave size.

Criterion Test: When the student completes this lesson topic, the student will express wire rope abbreviations, size, safe working load and breaking strengths, inspect for defects, replacing wire rope, wire rope connections, wire rope maintenance, and Sheave size.

LESSON TOPIC GUIDE

1.1 WIRE ROPE CONSTRUCTION AND CLASSIFICATION

I. Introduction	Instructor Activity
A. Establish contact	Introduce yourself and give topic for this lesson.
B. State lesson objective	
C. Establish readiness	
1. Motivate students	Use motivating statements.
a. Pass course b. Perform better on job c. Get advanced d. Be a better equipment operator	
2. Lesson overview	State learning objectives. 1. State information and materials necessary to guide students. 2. Notes may be taken. 3. Questions. 4. Classroom conduct. 5. Shop area conduct.

II Presentation

A. Safety Hazards

1. Broken wires - Use gloves.
2. Sheaves - Keep hands, fingers, and loose articles away from sheaves.
3. Fingers rings - Remove them before working.
4. Grease and solvents - Wash hands after use. Wear eye protection.
5. Eyes - Use eye protection when hammering or cutting wire rope.
6. Hard hat - At all time when working with crane.
7. Used wire rope - Cut and throw away. Do not use for slings, etc...

B. Avoiding Hazards

1. Face mask; goggles
2. Hard hats
3. Gloves
4. Hearing protection
5. Proper storage
6. Cleanliness

C. Attitude

D. Rope construction and classification

1. Strands
2. Standards rope classification
3. Wire rope abbreviations
   a. Strand construction
      (1). PRF - Performed
      (2). NP - Non-Performed
      (3). FW - Filler Wire
   b. Lays

(1). RRL - Right Regular Lay

(2). LRL - Left Regular Lay

(3). RLL - Right Long Lay

(4). LLL - Left Long Lay

c. Type of core

(1). FC - Fiber rope Core

(2). IWRC - Independent Wire Rope Core

(3). PPC - Polypropylene rope Core

(4). SC - Strand Core

d. Grade and finish of wire

(1). MPS - Mild Plow Steel

(2). PS - Plow Steel grade of wire

(3). IPS - Improved Plow Steel

(4). XIP - Extra Improved Plow steel

(5). GIS26 - Galvanized Iron Grade of wire for Seizing Strand

(6). Bright Wire without any coating, such as Zinc or tin.

e. Rope selections

f. Rope conditions

(1). Correct diameter. Wear not less then one-third the original diameter of outside individual wires.

(2). High stranding and unlaying

(3). Bird caging

(4). Rope kinks

(5). Core protrusion

(6). Broken wires

(a). In running ropes six randomly distributed running rope, no more than six broken wires in one lay or three broken wires in one strand in one lay.

(b). In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire and the end connection shall be replaced.

g. Rope construction

h. Seizing

i. Rope lubrication and maintenance

j. Sheaves

(1). Inspection

(2). Size

(3). Proper fitting

k. Methods of unreeling wire rope

(1). Reel to drum

(2). Winding rope

(3). Proper drum spooling

1.2 RIGGING AND SLINGS

Terminal Objective: Upon completion of this unit the student will have answered questions pertaining to the use of slings, clips, inspection, classification, lubrication, and proper splicing and knot tying using synthetic rope.

Enabling Objective: The student will be able to select the correct rigging for each job assign, and inspect slings and other type rigging for defects, lubricate and use proper sling and knot tying.

Criterion Test: When the student completes this lesson topic, the student will express the proper method for inspecting slings and other type rigging, select and use of rigging, sling, clips, and knot tying.

LESSON TOPIC GUIDE

1.2 RIGGING AND SLINGS

I. Introduction	Instructor Activity
A. Establish contact	Give topic of this lesson.
B. State lesson objective	
C. Establish readiness	
1. Motivate students	Use motivating statements.
a. Pass course b. Perform better on job c. Get advanced d. Be a better equipment operator	
2. Lesson overview	State learning objectives. 1. State information and materials necessary to guide students. 2. Notes may be taken. 3. Questions. 4. Classroom conduct. 5. Shop area conduct.
3. Presentation	
a. Safety hazards	
(1). Broken wires	gloves
(2). Finger rings	
(3). Grease and solvents	wash hands after use and use eye protection
(4). Hard hats	
(5). Tag-lines	

b. Avoiding hazards

(1). Hard hats

(2). Gloves

(3). Hearing protection

(4). Proper storage

(5). Cleanliness

(6). Attitude

c. Rope construction and classification

(1). Strands

(2). Standard rope classification

(3). Wire rope classification

d. Synthetics

(1). Ropes

(2). Web slings

e. Wire rope clips

(1). Installation Right and wrong way of u-belts. retightened after initial load has been applied.

(2). Efficiency rating

f. Forged shackles

(1). Safe working loads

(2). Sizes

(3). Pins

g. Hooks and hook block

(1). Inspection

(a). Safety latches

(b). Thread opening

(c). Cracks

(d). Loose or broken bolts and nuts

(e). Missing or broken safety clips

(f). Magnetic flux

h. Wedge sockets

(1). Inspection

(a). Wedge

(b). Socket

(c). Safety pin

(d). Socket pin

(e). Proper attached wire and clip on dead end

i. Spelter sockets

j. Wire rope thimbles

k. Sling saddle and protectors

l. Methods of rigging

(1). Wire rope

(2). Synthetics

(3). Choker and basket

1.3 PRE-OPERATIONAL/POST OPERATIONAL PROCEDURES

Terminal Objective: Upon completion of this unit the student will have answered questions pertaining to pre-operational/post operational procedures. The student will learn to check, adjust, rig, and perform operators maintenance.

Enabling Objective: The student will be able to pre start and perform post operational procedures, adjust, rig and maintenance as directed by operation conditions in accordance with manufacturer's specifications and recommendations.

Criterion Test: When the student completes this lesson topic, the student will express the proper procedures for pre-start, operator's maintenance and post operational procedures.

LESSON TOPIC GUIDE

1.3 PRE-OPERATIONAL/POST OPERATIONAL PROCEDURES

I. Introduction

Instructor Activity	
A. Establish contact	Give topic for this lesson.
B. State lesson objective	
C. Establish readiness	
1. Motivate students	Use motivating statements.
a. Pass course b. Perform better on job c. Get advanced d. Be a better equipment operator	
2. Lesson overview	State learning objectives.
	a. State information and materials necessary to guide students. b. Notes may be taken. c. Questions. d. Classroom conduct. e. Shop area conduct.
3. Presentation	
a. Safety	
(1). Hard hats	
(2). Gloves	
(3). Eye protection	

(4). Loose clothing

(5). Lubrication (never lube with engine running)

b. Attitude

c. Pre-operational procedures

(1). Thorough walk around visual inspection. Where a visual inspection cannot be made use indicators such as gauges, dipsticks, etc.

(2). Oil or water leaks; and rectify. Repair or replace any damaged or missing components before operating the machine.

(3). Bent, cracked or corroded structural members, or loose, broken, missing bolts and rivets.

(4). Cracked or corroded welds

(5). Tire condition, including tire pressure and lug nuts

(6). Hoses and fittings

(7). Air tanks valves; make sure they are closed

(8). Cleanliness of carrier; remove any oil, grease, and mud on ladders, walking surfaces and in the cab

(9). Fuel level; visually inspect level

(10). Protective guards and panels secure and in place

(11). Engine oil

(12). Hydraulic oil

(13). Turntable gear box oil level

(14). Engine cooling system level and hose condition

(15). Electrical

(a). Battery

(b). Electrolyte level

(c). Cables for cleanliness and tightness

(d). Operation of light, indicators, and warning devices

(e). Wiring for fraying, deterioration, and connections

(16). All drive belts for tension and wear

(17). Air cleaner; properly service

(18). Proper type and condition of fire protection devices

(19). Proper lubrication. Consult manufacturer's manual.

(20). Inspect rollers, roller path for wear, loose bolts, broken welds

(21). Check condition of counterweight and fasteners

(22). Verify that correct certified capacity charts are in crane

(23). Inspect boom angle indicator for free movements

(24). Iinspect sheaves for wear, roughness, cracks, free turning, alignment, and lubrication

(25). Check condition of wedge and socket, and dead end connections

(26). Check wire rope to insure proper type and reeving.

(27). Wire rope

(a). Size, new or used. Measure with caliper or crescent wrench.

(b). Lay, wrapped on drum properly

(c). Broken wires or strands, kinks, crushed, and two complete wraps at the end of the working radius

(d). Lubrication, gauge wire rope

(28). Hook block - Inspect for cleanliness, damage, cracked or worn sheaves, broken or loose bolts, worn pins, damage or worn check plates, and lubrication.

(29). Inspect hook for cracks, sharp edges, wear and throat opening on hook head to be equipped with a safety catch that works properly

(30). Insure that all outrigger pads and locking pins are in place

(31). During operation check

(a). Check for excessive heat, vibration, noise, oil and water leaks

(b). Gauges

(c). Check condition and function of Put out all outriggers, outriggers, pads, cylinder. mounting, and hydraulic hoses

(d). Check level indicators Level indicators usually unreliable. Double check with carpenters level. Sideways, fore and aft.

(e). Inspect tanks, lines, valves of air systems for leakage and roper operation.

(f). Inspect hydraulic system for leakage and proper operation

(g). Exhaust system for leaks and looseness

(h). Check steering, braking, locking devices for condition and operation

(i). Check all indicators and weight, angle and length meter, warning devices

(j). Swing lock

(k) . All controls swing, boom, hoist, and boom length.

(l). Unusual noises or vibration

(m). Rough or abrupt operation

(n). Ensure the drum has a minimum of two complete wraps of wire rope at lowest working level

(o). If new hoist line has been installed on the crane, work under light load for sufficient time to allow rope to adjust itself to drums and sheaves

(p). Ensure clips are installed correctly

32. Post operational procedures

(a). Bring in all outriggers; after boom is retracted, swing lock is engaged, and hook block is attach to the snubber

(b). Make sure crane is parked on high level ground where danger of flooding exists, and back away from high banks where danger of cave-ins exists.

(c). Set air brakes

(d). Shut off engine and all electrical switches

(e). Place transmission in neutral

(f). Close all windows

(g). Drain air tanks

(h). Make walk around visual inspection, checking for leaks, damage, missing parts, etc.....

(i). Check boom, wire rope, hook block and all other components, and structural members

(j). Check for loose, broken, worn bolts, cotter key, etc...

(k). Check overall condition of wire rope, hook block and sheaves

33. Summary

(a). Pre operational procedures

(1). Visual inspection

(2). Leaks

(3). Structural members; bents, cracks, missing bolts, and rivets

(4). Welds; cracked or corroded

(5). Tire condition

(6). Hoses and fitting

(7). Air tank valves

(8). Cleanliness

(9). Fluid levels

(10). Protective guards and panels

(11). Oil levels

(12). Cooling system

(13). Electrical

(14). Drive belts

(15). Air cleaner

(16). Fire protective devices

(17). Lubrication

(18). Rollers, pins, shafts, etc...

(19). Capacity charts

(20). Counterweights

(21). Fuel levels

(b). During operation check-boom, wire rope, hook block, and components

(1). Noise and vibration

(2). Rough operations

(3). Inspect wire rope

(4). Gauge wire rope

(5). Proper running on sheaves and hook blocks

(6). Two complete wraps

(7). New wire rope

(8). Wire rope lubrication

(9). Clips

(c). Post operational procedures

(1). Outriggers

(2). Engine and switches off

(3). Air brakes

(4). Transmission in neutral

(5) . Parking

(6). Drain air tanks

(7). Visual inspection

(8). Close windows

(9). Swing lock

(10). Lower boom

(11). Attach hook to snubber

(12). Doors and windows closed

(13). Visual inspection

(14). Bolts, pins, rollers, etc...

(15). Wire rope, sheaves, etc...

(16). Wrapped on drum properly

1.4 PREVENTIVE MAINTENANCE

Terminal Objective: Upon completion of this unit the student will have answered questions pertaining to preventive maintenance. The student will learn the importance of this task so that equipment will operate more efficient an reduce break downs.

Enabling Objective: The student will be able to perform preventive maintenance on lubricant all 8 hour fitting, wire rope, and recognize deficiencies before the fail.

LESSON TOPIC GUIDE

1.4 PREVENTIVE MAINTENANCE

I. Introduction

A. Establish contact

B. State lesson objectives

C. Establish readiness

II. Lesson overview

III. Preventive maintenance procedures

A. Visual inspection

1. Loose bolts
2. Loose or worn hoses and fittings
3. Cleanliness
4. Hoist line properly lubricated
5. Excess grease removed
6. Proper lubrication
7. Properly washed
8. Rust spots properly cleaned and inspected before painting

IV. Summary

1.5 TRAVEL/TRANSPORT CRANE

Terminal Objective: Upon completion of this unit, the student will be able to properly inspect job sites for overhead clearance, utility lines, ground stability, and state laws for transporting this type of equipment on Washington roads and highways.

Enabling Objective: The student will be able to state how to inspect job sites and transport a crane on Washington state roads and highways. The student will know who to call for transporting cranes.

Criterion Test: Upon completion of this lesson topic the student will express proper procedures for backing, passing, being overtaken by another vehicle, going through an intersection, demonstrating the knowledge of the relationship between the extended boom and carrier when going around curves/corners and under obstacles.

LESSON TOPIC GUIDE

1.5 TRAVEL/TRANSPORT CRANE

I. Introduction

- A. Establish contact
- B. State lesson objective
- C. Establish readiness

II. Motivate students

III. Lesson overview

IV. Presentation

- A. Wheel mounted crane nomenclature
  1. Koehring model LRT 180A
  2. One engine
  3. Upper revolving unit
  4. Three speed transmission and two speed transfer case
  5. 15 ton lifting capacity PCSA Class 15085
  6. Two operators or one operator and one rigger in most cases
  7. Fill out a crane lift checklist before starting out
- B. Traveling the crane
  1. Securing boom

a. Lower boom to a minimum of 14'(preferably lower)

b. Swing lock engaged

c. Hook block attached to snubber

2. Starting procedures

a. Outriggers in

b. Start engine PTO out. Engine must be off to engage or disengage PTO.

c. Check gauges

d. Release parking brake

e. Use proper gear selection

3. Backing procedures

a. Post signal man

b. Crane horn proper signals

4. Over the road operation

a. Passing

b. Being overtaken by another vehicle

c. Going through an intersection

d. Going around curves/ corners and under obstacles

For off base operation:

Contact local authorities when operating on public roads or high-ways, compliance with local regulations governing such use is the operators' responsibility

Be very careful when going along a bumpy road. With the weight of the boom out front the bouncing effect is multiplied. Front and rear wheels could leave the ground.

V. Summary

A. Wheel mounted crane nomenclature

B. Traveling the crane

C. Staring procedures

D. Backing up procedures

E. Over the road operations

1.6 SETTING OUTRIGGERS

Terminal Objective: Upon completion of this unit, the student will be able to properly inspect the ground at job sites and determine if the ground is stable for the crane. The student will extend the outriggers and level the crane properly.

Enabling Objective: The student will be able to state how to inspect the ground, extend and set outriggers and level the crane.

Criterion Test: Upon completion of this lesson topic the student will express proper procedures for inspecting the area, set outriggers, and leveling the crane.

LESSON TOPIC GUIDE

1.6 SETTING OUTRIGGERS

I. Introduction

- A. Establish contact
- B. State lesson objectives
- C. Establish readiness

II. Motivate Students

III. Lesson overview

IV. Presentation

- A. Safety hazards
  1. Soft ground
  2. Un-level ground
  3. Can the crane get into the site (room to maneuver)
  4. Is the access road adequately graded and compacted
  5. Will the crane have to travel over buried pipes (sewer mains, etc. that may crush?)
  6. Is there room for the outriggers when extended
  7. Is there any overhead obstructions
- B. Extending outriggers
  1. Situate for the job
  2. There will be at least 2' clearance between the counterweight and the nearest obstacle

3. Remove the safety pins from the outriggers and put them in the retainers

4. Install pads

5. Fully extend outriggers beams that are nearest the boom tip first, then extend the outrigger jacks so they just touch the ground

6. Fully extend the outrigger beams that are farthest from the boom and extend the outrigger jacks so they just touch the ground

7. level the crane so that no wheels are carrying the load

C. Accidents caused from improper use of outriggers

1. Failure to use outriggers

2. Failure to extend all outrigger beams

3. Failure to fully extend outrigger beams

4. Failure to get wheels off the ground

5. Failure to level crane

6. Poor blocking under floats

7. Set up too close to trenches, shoring locations, slopes, or embankments,

D. Retracting outriggers

1. Put boom back in the travel position

2. Retract outrigger jacks farthest from boom tip first until tires are touching the ground

3. Retract the outrigger jacks nearest the boom tip until tires are touching the ground

4. Retract all jacks the rest of the way using #2 and #3 sequence

5. Retract outrigger beams nearest from the boom tip

6. Retract outrigger beams farthest from the boom tip

V. Summary

A. Presentation

B. Extending outriggers

C. Accidents caused from improper use of outriggers

D. Retracting outriggers

Comments:

MASTER COURSE SCHEDULE

Day One

Unit/Topic	Type	Period	Title
0.1	Classroom	1	Orientation
0.2	Classroom	2	Safety
0.2	Classroom	3	Safety
0.2	Classroom	4	Safety
0.2	Classroom	5	Safety
0.2	Classroom	6	Safety
1.0	Classroom	7	Hand Signals

Day Two

1.1	Classroom	8	Wire rope Construction/Classification
1.1	Classroom	9	Wire rope Construction/Classification
1.2	Classroom	10	Rigging and Slings
1.2	Classroom	11	Rigging and Slings
1.3	Classroom	12	Pre-operational/Post Operational Procedures
1.3	Classroom	13	Pre-operational/Post operational Procedures
1.3	Classroom	14	Pre-operational/Post operational Procedures

Day Three

1.4	Classroom	15	Preventive Maintenance
1.5	Classroom	16	Travel/Transport Crane
1.6	Classroom	17	Setting out Riggers
1.7	Classroom	18	Operate Crane with Hook Block
1.7	Classroom	19	Operate Crane with Hook Block
1.7	Classroom	20	Operate Crane with Hook Block
1.7	Classroom	21	Operate Crane with Hook Block

Day Four

1.8	Classroom	22	Operate Crane with Clamshell
1.8	Classroom	23	Operate Crane with Clamshell
1.9	Classroom	24	Operate Crane with Personnel Basket
2.0	Classroom	25	Written Test (CerTest # 8163 & 8164)
2.1	Practical	26	Pre-operational Procedures
2.2	Practical	27	Pre-operational Check
2.2	Practical	28	Pre-operational Check

Day Five

2.2	Practical	29	Pre-operational Check
2.3	Practical	30	Setting out the out riggers
2.4	Practical	31	Operate Crane with Hook Block
2.4	Practical	32	Operate Crane with Hook Block
2.4	Practical	33	Operate Crane with Hook Block
2.4	Practical	34	Operate Crane with Hook Block
2.4	Practical	35	Operate Crane with Hook Block

Day Six

2.2	Practical	36	Pre-operational Check
2.4	Practical	37	Operate Crane with Hook Block
2.4	Practical	38	Operate Crane with Hook Block 2.4
2.4	Practical	40	Operate Crane with Hook Block
2.4	Practical	41	Operate Crane with Hook Block
2.4	Practical	42	Operate Crane with Hook Block

Day Seven

2.2	Practical	43	Pre-operational Check
2.4	Practical	44	Operate Crane with Hook Block
2.4	Practical	45	Operate Crane with Hook Block
2.4	Practical	46	Operate Crane with Hook Block
2.5	Practical	47	Performance Test
2.5	Practical	48	Performance Test
2.5	Practical	49	Performance Test

Day Eight

2.2	Practical	50	Pre-operational Check
2.6	Practical	51	Pre-check Clamshell
2.7	Practical	52	Setting Crane with Clamshell
2.8	Practical	53	Operate Crane with Clamshell
2.8	Practical	54	Operate Crane with Clamshell
2.8	Practical	55	Operate Crane with Clamshell
2.8	Practical	56	Operate Crane with Clamshell

Day Nine

2.2	Practical	57	Pre-operational Check
2.8	Practical	58	Operate Crane with Clamshell
2.8	Practical	59	Operate Crane with Clamshell
2.8	Practical	60	Operate Crane with Clamshell
2.8	Practical	61	Operate Crane with Clamshell
2.8	Practical	62	Operate Crane with Clamshell
2.9	Practical	63	Pre-operational Check Personnel Basket

Day Ten

2.2	Practical	64	Pre-operational Check
3.0	Practical	65	Operate Crane with Personnel Basket
3.0	Practical	66	Operate Crane with Personnel Basket
3.0	Practical	67	Operate Crane with Personnel Basket
3.1	Practical	68	Hook Block Back on Crane and Load Test
3.1	Practical	69	Hook Block Back on Crane and Load Test
3.1	Practical	70	Hook Block Back on Crane and Load Test

ANNUAL CRANE OPERATORS CERTIFICATION

OPERATORS NAME: _____ RANK: _____

SSN: _____

Physical Qualifications (AFOSH STD 127-10 and 127-46):

Item	Qualifying Requirement	Date Tested or Observed	Results	Signature of Approving Authority
Eyesight	Applicant must have minimum of 20/30 Snellen in one eye and 20/50 in the other, corrected			
Color Perception	Must be able to distinguish red, green and yellow colors regardless of position			
Hearing	Must be able to hear ordinary conversation in one ear to insure adequate hearing for a specific operation			
Physical Fitness	Must evidence sufficient strength, endurance agility, coordination, and speed of reaction to meet the demands of equipment operation			
Physical Defects or Emotional Instability	Must not evidence any physical defect on emotional instability that could render the individual a hazard to himself or others or safe operators performance			

Other Qualifications (AFOSH STD 127-10 and 127-46):

Item	Qualifying Requirement	Date Issued or Tested	Results	Signature of Approving Authority
Drivers License	Must have current drivers license issued by LGTV			
Certificate of Competency, AF Form 483	Issued after satisfactorily completing a certifying exam, a practical operating exam and meeting the minimum physical qualifications			

WHEEL-MOUNTED CRANE

APPENDIX II

PRACTICAL EXAMINATION

WHEEL-MONUTED CRANE

PRACTICAL EXAMINATION

All crane operator candidates must successfully complete a practical examination in addition to the written examination and hand signals examination. The practical examination should provide hands-on reinforcement of the information in this certification package.

The practical examination can be locally developed. However, it must include the following as a minimum:

1. Perform operator's inspection and maintenance.
2. Transporting the crane.
3. Proper crane setup at job site.
4. Determining lifting capacity using load charts.
5. Perform proper rigging.
6. Lifting and spotting a load.
7. Proper use of hand signals.
8. Changing cables.
9. Changing attachments.
10. Compliance with all safety requirements.

NOTE: Any safety violation is cause for immediate failure of the practical examination.

SAMPLE

WHEEL-MONUTED CRANE

PRACTICAL EXAMINATION

TASK	POSSIBLE POINTS
Perform Operator's Inspection	5
Perform Operator's Maintenance	5
Transporting the Crane	5
Crane Setup	5

Things to look for:
Proper crane stability
Properly determining lift capacity

Skill Development

Drop hook block in a 55 gal drum (without assistance) 40

You will need four 55-gal drums. Place one drum in each of the four lifting quadrants. The operator has to lift the hook block, swing, and lower the hook block into each of the 55-gal drums. The objective is to lift, swing and lower the hook block into the drum without touching the drum in a smooth and controlled manner.

Time Limits (per lift, swing, and lower):

0-60 Seconds	10 points
61-90 Seconds	9 Points
91-120 Seconds	8 Points

Things to watch for:
Touching the drum
Swing not smooth and controlled
Over or Under-shooting the drum

Drop hook block in a 55 gal drum (with spotter assistance) 10

You will need one 55-gal drum. Place the drum behind an obstacle so that the operator is unable to see it. The operator has to follow the spotter's hand signals to lift the hook block, swing, and lower the hook block into the 55-gal drum. The objective is to lift, swing and lower the hook block into the drum by following the signals given by the spotter without touching the drum. Again the lift , swing, and lower should be smooth and controlled.

Skill Development (continued)

Cone Obstacle Test	20

You will need ten 2-ft tall cones. Place the cones 10-ft apart, in a straight line, directly in line with the front center of the crane (cones should be in a straight line leading away from the crane. Additional cones (do not have to be same size) should be placed on both sides, parallel with the center cones, spaced 6-ft from the center cones. The objective is for the operator to begin with the hook block at the farthest cone with the boom fully extended at a 35 degree angle and the hook block grounded. The operator then manipulates the crane controls to maneuver the hook block in and out of the center cones while raising the boom, telescoping in, and swinging while keeping the hook block from raising above the 2-ft cones, touching the ground, or swinging beyond the outer cones.

Lifting and Spotting an actual load	10
Recognizing hand signals	10
Total Points Possible:	**110**

Students must accumulate a minimum number of points that instructor feels meets the practical requirements for certification.

WHEEL-MOUNTED CRANE

APPENDIX III

HAND SIGNALS PRACTICE EXAMINATION

HAND SIGNAL PRACTICE EXAMINATION

Background: All crane operators must be able to identify the hand signals associated with rigging and lifting. Failure to follow the signalman's hand signals could lead to an accident. To eliminate this potential problem, this hand signals examination was developed.

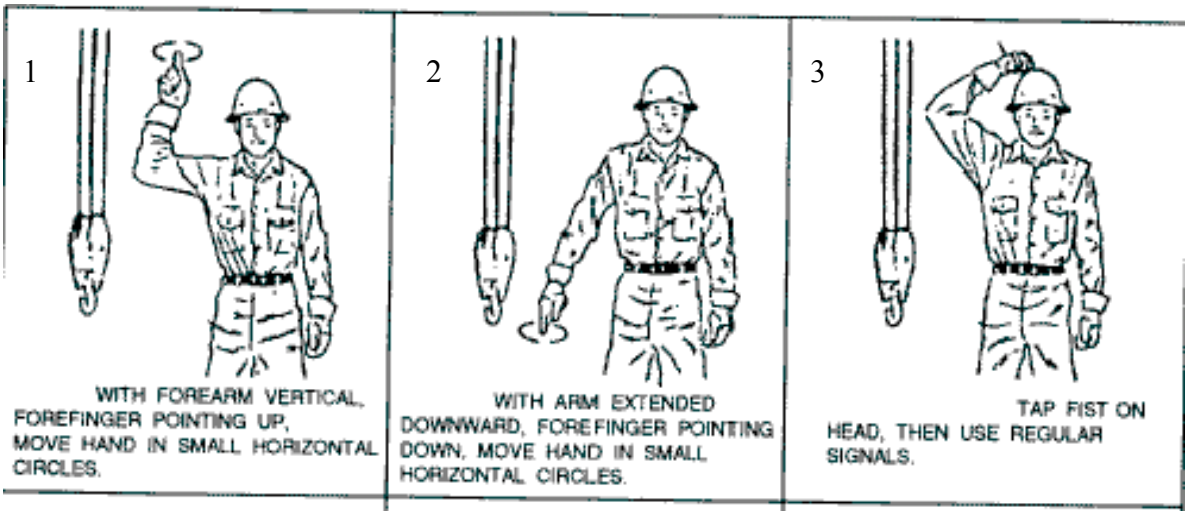
Objective: Each student must be able to identify the following hand signals with 100% accuracy.

If any hand signals are not answered correctly, then the student must review the hand signals in the certification package and re-attempt this examination. There is NO exception.

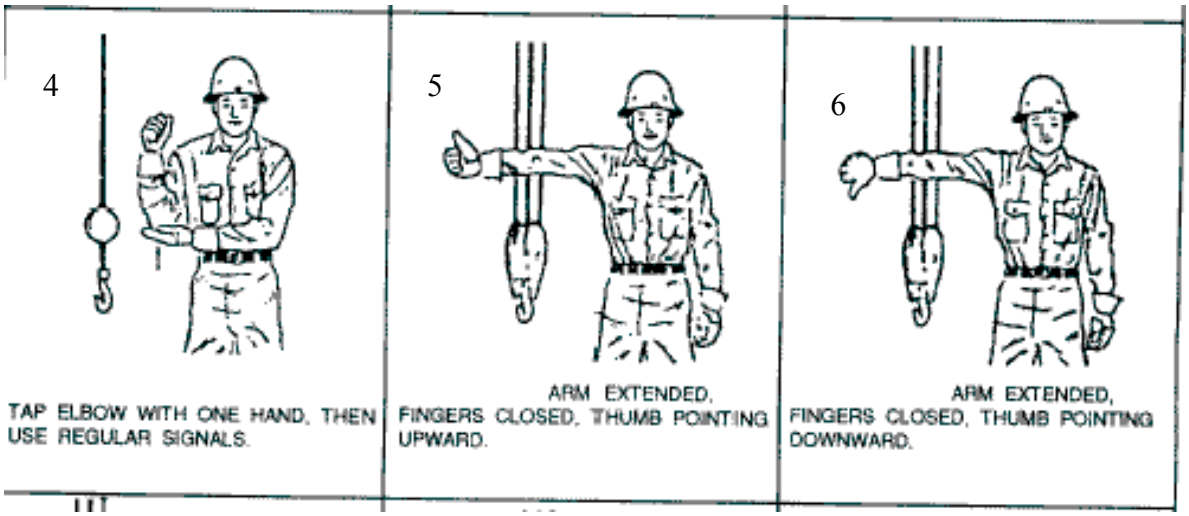
If a student is unable to pass this hand signal examination, then they cannot be certified as a crane operator.

Directions: Using a list of hand signals, identify the pictures representing those hand signals. Write the hand signal identification from the list, on the line below the picture representing that particular signal.

The CerTest will also include hand signal questions.



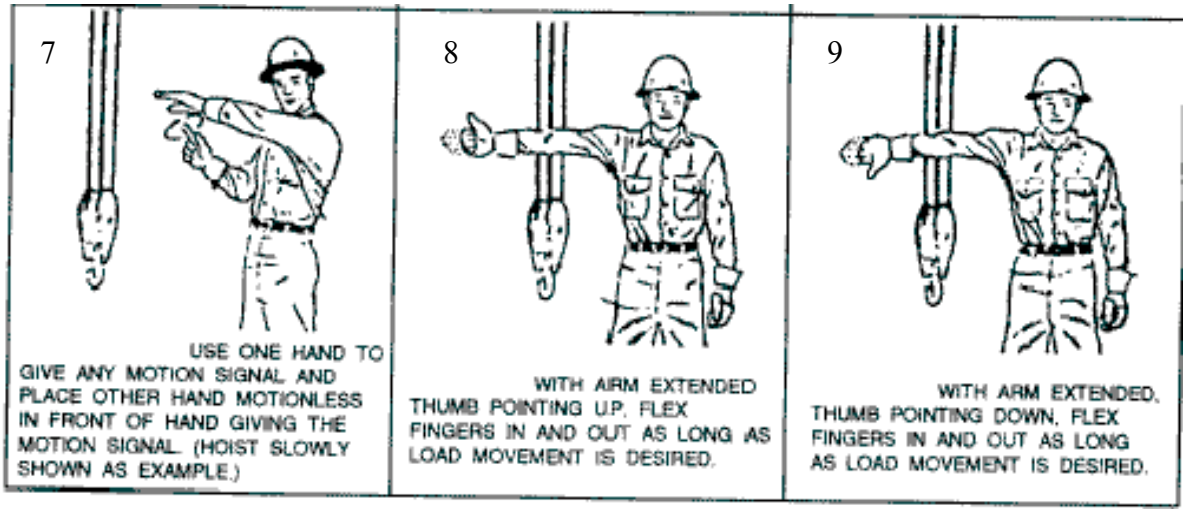
1. _____ 2. _____ 3. _____



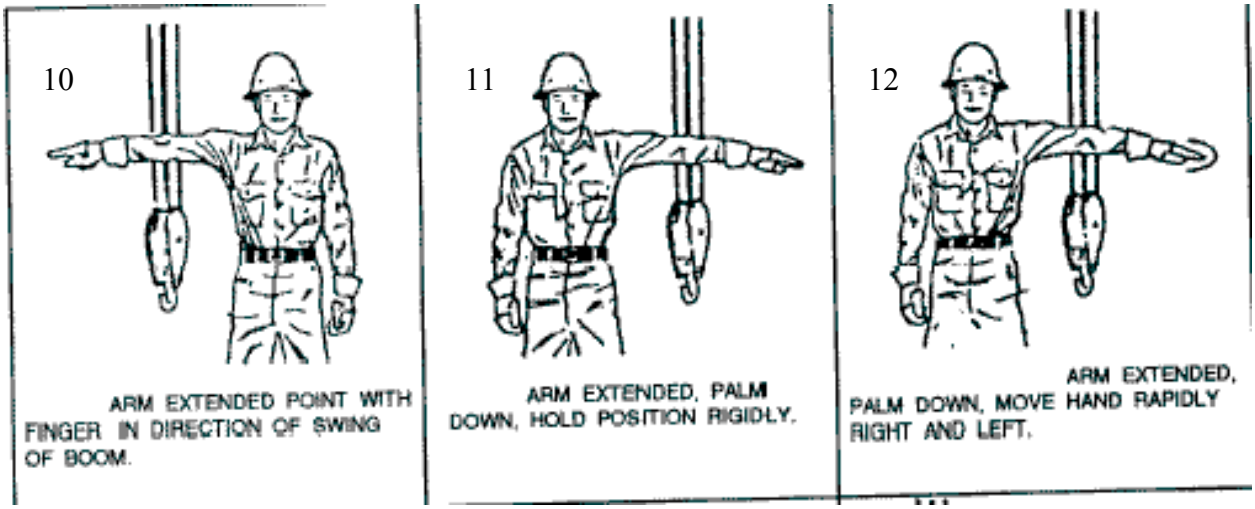
4. _____ 5. _____ 6. _____

Hand Signals:

1. Travel (one track)
2. Dog Everything
3. Emergency Stop
4. Move Slowly
5. Raise Boom
6. Use Main Hoist
7. Extend Boom (Telescoping) One Hand Signal
8. Lower the Boom/
9. Hoist
10. Retract Boom (Telescoping)
11. Swing
12. Retract Boom (Telescoping) One Hand
13. Travel
14. Use Whip Line
15. Lower
16. Stop
17. Raise the Boom/Lower the Load
18. Travel (both tracks)
19. Extend Boom
20. Lower Boom



7. _____ 8. _____ 9. _____

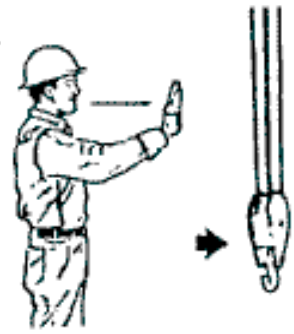


10. _____ 11. _____ 12. _____

Hand Signals:

1. Travel (one track)
2. Dog Everything
3. Emergency Stop
4. Move Slowly
5. Raise Boom
6. Use Main Hoist
7. Extend Boom (Telescoping) One Hand Signal
8. Lower the Boom/
9. Hoist
10. Retract Boom (Telescoping)
11. Swing
12. Retract Boom (Telescoping) One Hand
13. Travel
14. Use Whip Line
15. Lower
16. Stop
17. Raise the Boom/Lower the Load
18. Travel (both tracks)
19. Extend Boom
20. Lower Boom

13



ARM EXTENDED FORWARD, HAND OPEN AND SLIGHTLY RAISED, MAKE PUSHING MOTION IN DIRECTION OF TRAVEL.

14

CLASP HANDS IN FRONT OF BODY.

15

USE BOTH FISTS, IN FRONT OF BODY, MAKING A CIRCULAR MOTION, ABOVE EACH OTHER, INDICATING DIRECTION OF TRAVEL, FORWARD OR BACKWARD (FOR CRAWLER CRANES ONLY.)

13. _____ 14. _____ 15. _____

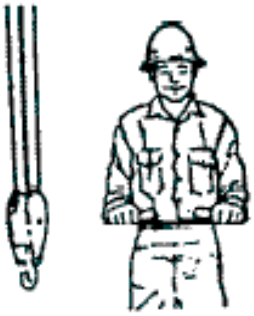
16

(ONE TRACK) LOCK THE TRACK ON SIDE INDICATED BY RAISED FIST, TRAVEL OPPOSITE TRACK IN DIRECTION INDICATED BY CIRCULAR MOTION OF OTHER FIST, ROTATED VERTICALLY IN FRONT OF BODY (FOR CRAWLER CRANES ONLY.)

17

BOTH FISTS IN FRONT OF BODY WITH THUMBS POINTING OUTWARD.

18



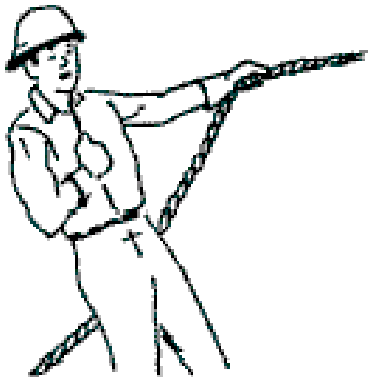
BOTH FISTS IN FRONT OF BODY WITH THUMBS POINTING TOWARD EACH OTHER.

16. _____ 17. _____ 18. _____

Hand Signals:

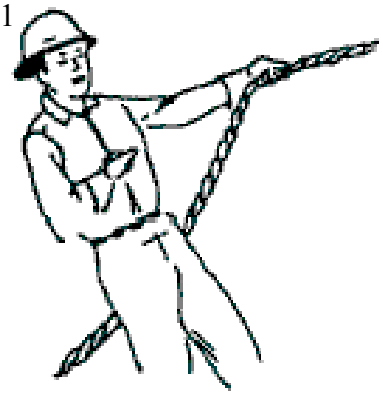
1. Travel (one track)
2. Dog Everything
3. Emergency Stop
4. Move Slowly
5. Raise Boom
6. Use Main Hoist
7. Extend Boom (Telescoping) One Hand Signal
8. Lower the Boom/
9. Hoist
10. Retract Boom (Telescoping)
11. Swing
12. Retract Boom (Telescoping) One Hand
13. Travel
14. Use Whip Line
15. Lower
16. Stop
17. Raise the Boom/Lower the Load
18. Travel (both tracks)
19. Extend Boom
20. Lower Boom

20



ONE HAND SIGNAL. ONE FIST IN FRONT OF CHEST WITH THUMB TAPPING CHEST.

21



ONE HAND SIGNAL. ONE FIST IN FRONT OF CHEST, THUMB POINTING OUTWARD AND HEEL OF FIST TAPPING CHEST.

19. _____ 20. _____

Hand Signals:

1. Travel (one track)
2. Dog Everything
3. Emergency Stop
4. Move Slowly
5. Raise Boom
6. Use Main Hoist
7. Extend Boom (Telescoping) One Hand Signal
8. Lower the Boom/
9. Hoist
10. Retract Boom (Telescoping)
11. Swing
12. Retract Boom (Telescoping) One Hand
13. Travel
14. Use Whip Line
15. Lower
16. Stop
17. Raise the Boom/Lower the Load
18. Travel (both tracks)
19. Extend Boom
20. Lower Boom

WHEEL-MOUNTED CRANE

APPENDIX IV

HAND SIGNALS AND GENERAL KNOWLEDGE EXAMINATION

See your Unit Education & Training Manager to complete the CerTest "CRANE CERT. TEST".

Successful completion of CerTest #'s 8163 & 8164, with a minimum passing score of 80% provides the required knowledge testing for certification as directed in AFI 10-210.